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Assessment of marginal adaptation of lithium disilicate and nanoceramic resin crowns using CAD/CAM system

Abstract

The aim of this study is to assess the marginal adaptation of different ceramic materials produced by the CEREC system (Sirona, Germany). An analog of the solid abutment Straumann (Straumann, Basel, Switzerland) measuring 5.5mm of height, with platform of 4.8mm, tilt from the axial wall of 6 degrees and chamfer finish line was used as a master model and scanned with an intraoral scanner (CEREC Omnicam). 20 machined crowns were obtained - 10 manufactured from lithium disilicate blocks (IpsE.maxCad, IvoclarVivadent, Liechtenstein, Germany), 10 manufactured from nanoceramic resin blocks (3M ESPE Lava Utimate, USA). The assessment was made using the Replica Technique (RT) and the cementation coating was measured using an optical microscope Mitutoyo (TM 500). Results show a mean marginal disadaptation of lithium disilicate crowns of 78.63µm, which is significantly larger than the one found for nanoceramic resin crowns - 63.15µm. It is possible to conclude that nanoceramic resin crowns have a better marginal adaptation than lithium disilicate ones. Notwithstanding, results found for both groups are within the clinically acceptable values for indirect restorations.

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Introduction

In the last years, CAD/CAM technology improved greatly and has provided several applications in dentistry. A variety of drillable materials are available in CAD/CAM for virtually all restoration indications. This technology allows accurate, standardized and fast prosthetic results. One of the main factors for the success of a restoration is marginal adaptation. A large disadaptation between tooth and cement might cause the dissolution of cement, resulting in biofilm accumulation and possibly the occurrence of cavities and/or periodontal disease. Vertical discrepancy at the edge of the restoration is acceptable up to 120µm because it causes smaller cement dissolution.[1] The replica and microscopic techniques have been effectively used to assess crown marginal discrepancy.[2–5] Ceramic restorations have been widely used in dentistry. Several materials are available in the market, such as lithium disilicate and nanoceramic resin. Lithium disilicate is more resistant and present longer lifespan in clinical use. The nanoceramic resin is a hybrid material that unites the properties of both ceramic and resin.[6] Also, materials with different resistances have different abilities to promote adaptation when machined. Materials with larger resistance are less machinable.[7] This study compares the marginal adaptation of nanoceramic resin (3M ESPE Lava Utimate, USA) and lithium disilicate (IpsE.maxCad, IvoclarVivadent, Liechtenstein, Germany) crowns, machined in a CAD/CAM system, after the assessment of the replica technique using optical microscopy.

Proposition

The aim of this study is to compare the marginal adaptation of lithium disilicate (IpsE.maxCad, IvoclarVivadent, Liechtenstein, Germany) and nanoceramic resin (3M ESPE, Lava Ultimate, USA) crowns, machined in a CAD/CAM system, after the assessment of the replica technique using optical microscopy.

Materials and methods

This study was approved by the Ethics Committee of the Dentistry School and Research Center São Leopoldo Mandic, under waiver protocol 2015/0488.

An anatomical abutment Straumann® IPS e-max® (Straumann®, Basel, Switzerland) with dimensions of 5.5mm of heigth, platform of 4.8mm, tilt of the axial wall of 6º and chamfer finish was used as master model.

The die was digitized using an intra-oral scanner Omnicam (Sirona Company, Bensheim, Germany). The crown was simulated using software CAD CEREC 4.4.4 (Sirona Company, Bensheim, Germany).

A milling machine MCXL (Sirona Company, Bensheim, Germany) was used to produce 20 actual crowns-10 of lithium disilicate (IpsE. maxCad, IvoclarVivadent, Germany), and 10 of nanoceramic resin (3M ESPE, Lava Utimate, USA) (Figure 1).

Figure 1 Machined crowns.

The replica technique was used to measure the marginal disadaptation.[4,5]

The assembly abutment-analog was attached to a liner Bioart B2, (Bioart Equipamentos Odontológicos Ltda, São Carlos; Brazil) and inserted into a bipartite acrylic box measuring 2.5cm of width and 2.5cm of height containing, in one half, heavy addition silicone Take 1 Advanced (Kerr Dental, Munich, Germany) for the conformation of the spatial positioning mold.

The crown was cemented to the abutment with light silicone Take 1 Advance (Kerr Dental, Munich, Germany) and repositioned on the heavy silicone mold with a 2kg load on the liner for 2 minutes for the silicone polymerization (Figure 2). The abutment was then removed and the gap created was filled with extra light silicone Take 1 AdvanceMonophase (Kerr Dental, Munich, Germany). The other half of the box was filled with the same heavy silicone and repositioned for the shaping of the abutment replica in fluid silicone.

Figure 2 Cemented crown with fluid silicone.

The replica was covered with medium addition silicone Take 1 Advanced mono/medium (Kerr Dental, Munich, Germany). Following polymerization, it was covered with heavy silicone, forming a replica of the abutment-cement-crown complex. This replica was split in 4 equal parts, and the silicone layer relative to the cementation line was measured in 4 points - mesial, distal, vestibular, and lingual - using a Mitutoyo TM500 (Mitutoyo, Tokyo, Japan) microscope with 30x of magnification (Figure 3). The measurements were submitted to statistical analysis.

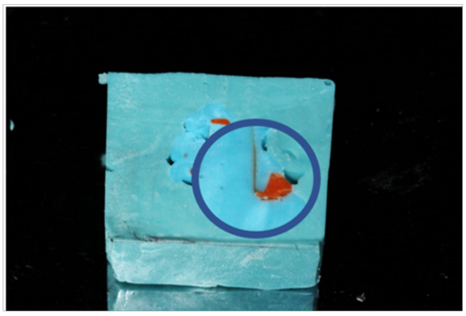

Figure 3 Silicone coating on the marginal disadaptation.

Results

The mean values of marginal disadaptation are shown in Tables 1−3.

Student's t-test showed that the groups differ with level of significance of 0.05.

Table 1 Mean marginal disadaptation of the test specimens (CP) in micrometers obtained from nanoceramic resin blocks

Nanoceramic resin	Vestibular	Lingual	Mesial	Distal	Mean	Standard deviation
CP1	42	43	56	41	45.50	7.05
CP2	62	50	41	43	49.00	9.49
CP3	89	68	43	74	68.50	19.16
CP4	95	80	83	74	83.00	8.83
CP5	63	71	65	56	63.75	6.18
CP6	87	65	67	63	70.50	11.12
CP7	56	65	82	67	67.50	10.79
CP8	87	73	72	84	79.00	7.62
CP9	56	77	76	45	63.50	15.67
CP10	43	34	45	43	41.25	4.92
				Mean	63.15	
				Standard deviation	13.9	

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Table 2 Mean marginal disadaptation of the test specimens (CP) in micrometers obtained from lithium disilicate blocks

Lithium disilicate	**Vestibular**	**Lingual**	**Mesial**	**Distal**	**Mean**	**Standard deviation**
CP1	90	76	83	64	78.25	11.09
CP2	73	66	54	77	67.50	10.08
CP3	76	67	73	84	75.00	7.07
CP4	56	71	73	79	69.75	9.78
CP5	116	98	99	87	100.00	11.97
CP6	89	84	83	88	86.00	2.94
CP7	15	116	95	87	78.25	43.90
CP8	87	98	78	71	83.50	11.68
CP9	77	73	71	69	72.50	3.42
CP10	66	56	88	92	75.50	17.31
				Mean	78.63	
				Standard deviation	9.42	

Table 3 Standard deviation per group

Group	Mean	Standard deviation	p-value*
Nanoceramic resin	63.15	13.9	0.009
Lithium Dissilicate	78.63	9.42	

*Student's t-test for homogeneous variances

Levene's test p=0.228

Shapiro Wilk's test confirmed normal distribution and Levene's confirmed homogeneity of variances. All statistical tests were conducted on SPSS version 20.0.

Discussion

With the latest technological development, digital solutions have progressively replaced manual processes in all contexts. Dentistry is one of them. New systems and software are routinely being developed and it is up to science to investigate their efficacy. With this in mind, this study aims to contribute to the understanding of CAD/CAM systems application in dentistry.

Restorations with poor marginal adaptation are subjected to cement dissolution and early failure. A marginal disadaptation of more than 120µm show high rate of cement dissolution, thus defining its acceptable limit.[1]

The use of CAD/CAM technology for the manufacture of indirect restorations has been questioned in terms of its ability to promote good marginal adaptation. Some authors have compared conventional with digital methods.[1–5,10–12] Most of these studies failed to find significant differences between the two approaches. However, Colpani et al.,[3] found better results using the conventional method of manufacturing of prostheses, and Zarauz et al.[5] found the opposite. Nonetheless, both techniques showed satisfactory results. Only a few studies show clinically unacceptable results when using CAD/CAM systems to produce the restorations. One such example is the study by Vojdani et al.,[9] that used a combination of conventional and digital methods.

Having established that CAD/CAM systems are capable to promote good marginal adaptation, some studies have engaged in studying the factors influencing the good adaptation of prostheses within the digital workflow.[13–15]

Some authors (Camargo et al. (2004), Ribeiro et al.,[13] Jalali et al.[14]) found no differences in terms of marginal adaptation when comparing different preparations. On the other hand, Ates &Yesil[15] compared shoulder and chamfer finish lines and found better results with the latter. This is the finish line used here.

Some studies compare marginal adaptation of different CAD/CAM systems. They conclude that CAD/CAM systems, software and parameters within given software may interfere in marginal adaptation.[17] Hamza et al.[16] used the same CAD/CAM system used here and all results were clinically acceptable.

Some other studies assessed only the system's milling machine.[7] They show significant differences in marginal adaptation depending on the type of milling machines, due mainly to the number of axes and thickness of burs. All the authors used, in at least one group, the same milling machine used here and obtained clinically acceptable results.

This study aimed at comparing the marginal adaptation of different materials. This was already done by some authors, with different methodologies.[6,7,10,18–20] There is a consensus among them that different materials present different marginal adaptation results, which is in agreement with the results of the present study.

Marginal adaptation is directly linked to the resistance of the material, which interferes in its machinability. Less resistant materials are less machinable.[6,7,20,21] This is also in agreement with this study's findings of a marginal adaptation of 63.15µm of the nanoceramic resin group, significantly smaller than the one found for the lithium disilicate group, of 78.63µm. Despite this difference, based on the literature limits, the lithium disilicate group presented an acceptable result.[10,19,20–23]

Conclusion

Based on the results presented here, it is possible to conclude that:

1. Nanoceramic resin crowns present better marginal adaptation than lithium disilicate ones.
2. The materials tested here promote a clinically acceptable marginal adaptation.

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Conflict of interest

The authors declare that there is no conflict of interest.

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