

A Comparative Evaluation of Marginal Fit of Cad-Cam Milled Pmma Crowns Fabricated By Three Different Techniques -An In Vivo Study

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Abstract

AIM:

The aim of this study is to compare and evaluate the marginal fit of CAD-CAM milled PMMA crown fabricated by three different technique

Material And Methods

10 participants were selected who have undergone root canal treatment and mandibular first molar teeth were prepared with a shoulder margin. It was scanned using an intra oral scanner (Dentsply Sirona) of prepared teeth, extraoral scanning of impression and extraoral scanning of casts. The PMMA crown was designed using the scanned STL file with CAD software (Dentsply Sirona).

Results

Accuracy of marginal fit were higher for extraoral scanning of impression compared with intraoral scans and extraoral scanning of die.

Conclusions

Intraoral conditions negatively influenced the accuracy of the scanning devices which was also reduced for the extraoral scanning of die.

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I. Introduction:

Computer-aided design and computer-assisted manufacturing (CAD-CAM) and intraoral digital scanners have become popular as alternatives to conventional impression making and casting methods, especially with the introduction of a new range of digitalization tools and scanners.¹ while processing the CAD-CAM fabricated restorations which includes procedure likes scanning, restoration design, milling, and sintering. Indirect laboratory digitizing uses a conventional impression, and then the impression or a gypsum cast is digitized by using a scanner whereas with direct intraoral digitization, the prepared tooth is scanned without a conventional impression.^{2,3}

Provisional restorations provide useful diagnostic value through assessment of functional, aesthetic, and occlusal parameters before the completion of the definitive restoration.⁴ Marginal misfit may cause plaque retention, bacterial contamination, and related periodontal problems, in addition to delayed or inadequate healing of traumatized soft tissues.⁵

When we use the conventional impression technique that does not require any special equipment. However, patient discomfort, bacterial contamination, technique sensitivity, and the long process are disadvantages of this method.^{6,7} The use of an intraoral scanner simplifies the procedure.⁷

However, the IOS has limitations, including the difficulty of scanning subgingival finish lines, patient movement, moisture, access difficulties, and the need to apply powder with some IOSs.^{8,9} Because of the access difficulties, IOSs have a smaller tip than extraoral scanners (EOSs). Therefore, multiple captures are required with an IOS. These problems can be mostly solved by steady and accurate extraoral digitizing.⁹ However, extraoral digitizing can lead to cumulative errors from the impression and gypsum casts⁸

The aim of this study was to compare the marginal fit of CAD/CAM milled poly(methyl methacrylate) (PMMA) crowns fabricated using three different scanning methods in CAD/CAM . The null hypothesis was that there is no difference in the marginal fit of the crowns fabricated using different techniques.

The marginal and internal fit of restorations made with three different methods has been compared. Although it is claimed that the impression could be directly digitized by using an intraoral scanner, therefore, the purpose of this in vivo study was to compare the marginal fit of PMMA crowns fabricated with intraoral scanner, extraoral scanner and extraoral scanning of impression. The null hypothesis was that the marginal gap would not differ among the crown fabricated with different scanning methods.

II. Materials And Methods:

A total of 10 participants needing a single restoration on endodontically restored teeth were selected.

Inclusion criteria

- Endodontically restored mandibular first molar with one or two cusps missing but $\geq 50\%$ coronal tooth structure present.
- patient above 18 years of age

Exclusion criteria

- poor oral hygiene
- bruxism
- patients under the age of 18.

An informed consent was obtained from all the participants enrolled in the study. For each participant three different types of crowns and a total 30 crowns were fabricated-

3 groups-

Group 1 - Intraoral scanning of prepared teeth

Group 2 – Extraoral scanning of casts and

Group 3 - Extraoral scanning of impressions

Teeth were prepared following ideal guidelines. Prepared teeth were scanned by intraoral scanner for group 1. Impression of the prepared teeth were made using polyvinyl siloxane material a were poured in type IV gypsum to obtain the master casts. Cast prepared from gypsum scanned by using a extraoral scanner for group 2. Then a conventional impression with polyvinyl siloxane material digitized with the extraoral scanner for group 3. Crowns fabricated using the scanned images with cad software. Crown design were finalized and information exported to cam software.

30 PMMA crowns were fabricated for three groups (n=10) The marginal and internal gaps of crowns were recorded using a replica technique with light body silicone material stabilized with a regular set putty. For the measurement of the marginal gap following procedure was used; The prepared silicone replicas were indexed at four sites using a marking pen—midfacial, mid-palatal, midmesial, and middistal surface and all of them were cut at these sites. From each replica , 4 sections were obtained in this way. Each of the section was then transferred on a trinocular stereomicroscope and images were clicked for each of them by using a digital camera (Nikon 3500 DSLR Camera). A total of 20 images obtained for each of 4 groups. All the images transferred to digimizer image analysis program version 5.3.4, medcalc software and the vertical marginal gap was measured for each section.

III. Results:

Results of one-way ANOVA indicated that the different crown fabrication techniques significantly affected the marginal gap values ($P < .001$) [Table 1]. The mean marginal gap obtained was smaller when the crowns fabricated by extraoral scanning of impression ($P < .001$). fig 1 Inter group comparison (>2 groups) was done using Kruskal Wallis ANOVA followed by pair wise comparison using Mann Whitney U test.

For all the statistical tests, $p < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80

Table 1

There was a statistically highly significant difference seen for the values between the groups (p<0.01)

	Group	N	Mean	Std. Deviation	Std. Error	Chi square value	p value of Kruskal-Wallis Test
buccal	1	10	105.080	3.9126	1.2373	24.790	0.000**
	2	10	79.770	8.2876	2.6208		
	3	10	58.893	5.6369	1.7825		
mesial	1	10	105.410	3.3345	1.0545	23.063	0.000**
	2	10	77.520	9.8396	3.1115		
	3	10	59.160	6.1515	1.9453		
distal	1	10	104.600	3.1269	.9888	24.039	0.000**
	2	10	80.410	8.4821	2.6823		
	3	10	58.750	6.3827	2.0184		
lingual	1	10	105.520	3.2700	1.0341	24.545	0.000**
	2	10	80.350	8.5261	2.6962		
	3	10	59.960	5.7574	1.8206		
avg	1	10	105.15250	2.155208	.681537	24.289	0.000**
	2	10	79.51250	8.501546	2.688425		
	3	10	59.19075	5.927818	1.874541		

for buccal with higher values in group 1

mesial with higher values in group 1

distal with higher values in group 1

lingual with higher values in group 1

avg with higher values in group 1

**Inter group Pair wise comparison using Mann-Whitney U test
Between groups 1 vs 2**

Table 2

	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
buccal	2.000	-3.628	0.000**
mesial	4.000	-3.477	0.001**
distal	4.000	-3.477	0.001**
lingual	2.000	-3.630	0.000**
avg	2.000	-3.628	0.000**

There was a statistically highly significant difference seen for the values between the groups (p<0.01) for all sites & avg

Between groups 1 vs 3

Table 3

	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
buccal	0.000	-3.781	0.000**
mesial	0.000	-3.780	0.000**

distal	0.000	-3.781	0.000**
lingual	0.000	-3.781	0.000**
avg	0.000	-3.780	0.000**

There was a statistically highly significant difference seen for the values between the groups ($p < 0.01$) for all sites & avg

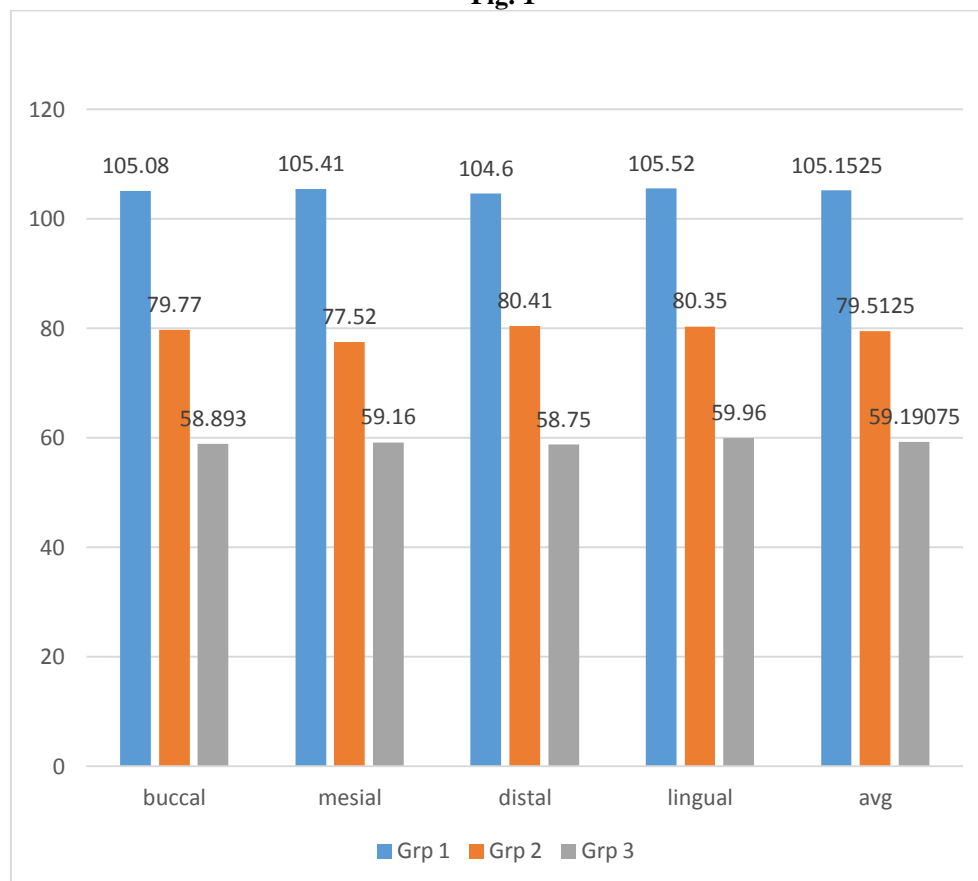
Between groups 2 vs 3

Table 4

	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
buccal	2.000	-3.630	0.000**
mesial	7.000	-3.250	0.001**
distal	3.000	-3.554	0.000**
lingual	3.000	-3.556	0.000**
avg	4.000	-3.477	0.001**

There was a statistically highly significant difference seen for the values between the groups ($p < 0.01$) for all sites & avg.

Fig. 1



IV. Discussion:

The main methods of data acquisition for fabricating PMMA crowns are direct and indirect digitization methods. The null hypothesis was rejected as extraoral scanning of impressions provided significantly lower marginal gap than the other methods tested. The IOS used in the study did not require a powder. This in vivo study¹⁰ stated that the extraoral scanning tested was more precise than the intraoral scanning. Loss of information at the edges of the tooth was reported with the IOS, while the precision of EOS was not lower in areas of high curvature and undercuts. The present study also detected that the crown fabricated based on

extraoral scans had significantly lower vertical marginal gap when the impression was scanned rather than the cast.¹¹

This study also detected that the crowns fabricated based on extraoral scans had significantly lower marginal gap when the impression was scanned rather than the cast. The reason for the selection of a natural tooth as the test material was to eliminate the potential dimensional stability and wear issues reported in the literature when acrylic resin, stainless steel, or stone tooth models were scanned and crowns were tried on those dies.⁵

The fit of provisional restorations is an important clinical requirement for the successful preservation of prepared teeth and at the same time underlying periodontal tissues .if the marginal fit is not proper in case of provisional restoration, the definitive restoration may be delayed, or the gingival appearance may not turn out as expected after the definitive restoration is delivered, especially in the esthetic zone. Thus, a proper fit of provisional crown affects the success of the definitive restorations.

Because it was reported that horizontal misfit may potentially be adjusted more easily than the crown vertical misfit, the aim was to test vertical misfit in this study.¹² Two sets of techniques have been reported in the literature to measure marginal and internal gaps: cementation, embedding, and sectioning specimens for measurement; and using PVS for cementation and non invasive measurement of this PVS replica of the internal and marginal gaps.¹³ The measurements were made using a modified form of the PVS replica technique, as has been previously described in the literature.^{13,14} The study on PMMA crowns showed similar results to the previously conducted studies evaluating definitive restorative materials

V. Conclusion:

Within the limitations of this study, the marginal gap values for the PMMA crowns were within the clinically acceptable range for All three groups (150 um). As the crowns were designed and milled on CAD-CAM with three different techniques of scanning. Based on the findings of this in vivo study, the following conclusions were drawn:

1. Marginal adaptations of all PMMA crowns fabricated with the 3 tested techniques were within a clinically acceptable range.
2. Extraoral scanning of the impression was the best method to collect digital data for marginal gap.
3. Intraoral scanning of the prepared teeth resulted in the highest vertical marginal gap among the 3 tested techniques.

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