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The Differences among Marginal Fit Of All-Ceramic CrownsObtained from One-Step Putty-Wash,Two-Step Putty-Wash and DigitalImpressionTechniques

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Abstract:
Background*: Clinical success and long-term use of fixed dentures are influenced by esthetic values, fracture resistance, and crown adaptation. Crown adaptation is defined as its axial and occlusal fit (internal fit) along with its marginal adaptation to the preparation (marginal fit). Poor marginal fit has been plaque accumulation which can initiate gingival inflammatory reactions and may lead to deterioration of the soft tissues due to periodontal disease, it also causes recurrent caries and bone loss. One of the significant factors for produce restorations with accurate internal and marginal fit is the impression technique. There are two techniques for dental impression, conventional impression using a one-step putty-wash technique, and two-step putty-wash technique and digital impression using direct and indirect. This study aims to find the differences amongmarginal of all-ceramic crownsobtained from one-step putty-wash, two-step putty-wash, and digital impression techniques.*
MATERIAL AND METHOD*: The design of this study was an experimental laboratory with a post-test of control group design. The samples for the three groups are 27 samples, 9 samples from the results of one-step putty-wash, 9 samples from two-step putty-wash, and 9 samples from the digital impression. All samples were measured for marginal fit using a stereomicroscope. Statistical analysis uses the Kruskal Wallis test to determine differences in ceramic crowns.*
RESULTS: *The result from the Kruskal-Wallis test there was no difference in marginal fit between the three groups with a value of p = 0.31 (p> 0.05).*
CONCLUSION:*There is no difference in the marginal fit of ceramic crowns obtained from one-step putty-wash, two-step putty-wash, and digital impression techniques and has a good and clinically acceptable marginal fit.*
Key Word*: marginal fit, one-step putty-wash, two-step putty-wash, CAD/CAM*

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I. Introduction

Fixed dentures are a retentive and strong restoration to replace the missing teeth. Crown is an extra coronal restoration assembled permanently or cemented covers the surface of clinical crowns. The clinical success and long-term use of fixed dentures are influenced by the aesthetic values, fracture resistance, and crown adaptation. Crown adaptation is defined as the axial and occlusal fit (internal fit) along with marginal adaptation for preparation (marginal fit) [1-4]

The poor marginal fit causes more plaque accumulation which could initiate gingival inflammatory reactions and can cause soft tissue damage due to periodontal disease and cause recurrent caries and bone resorption. Marginal fit is inseparable from the marginal value of the gaps. Marginal gaps in the quantitative values of the distance (difference) between the edge of the crown and the teeth preparation limit. [5,6.]

A significant factor for generating the restoration with accurate internal and marginal fit is the impression technique.3 If the impression technique failed to produce an accurate preparation, it will affect the improper crowns which can lead to larger marginal gaps that can be directly related to gingival inflammation if placed sub-gingival or caries if placed supragingival. The quality and accuracy of reproduction are very dependent on the impression technique used, the impression material used, and the accuracy of the cast. 4 There are two techniques for dental impression, such us conventional impression using elastomer molds with the one-step putty wash technique and two-step putty-wash technique and direct and indirect digital impression.[7]

The one-step putty-wash technique is the impression process using putty and washes material that stirs simultaneously. The putty material is put into the impression tray and at the same time, the wash material is also placed simultaneously in the supporting dental. The two-step putty-wash impression technique is the technique that made the putty material first and left set, then the wash material added and mold reinserted.

The conventional impression is considered a complicated process because of the obstacle, discomfort, nausea, unsatisfactory feeling, prolonged time, and the bubble inclusion that can cause potential damage forpatients and dentists.[8] The weaknesses of conventional dental impression are the basis for innovation for improvement in the digital dental impression.

The digital impression techniques can make it easier for clinicians to get data on the direct oral cavity condition without using impression material. The significant advantages of digital impression for fixed prosthodontic compared with conventional impression technique is the short time interval needed for clinician and laboratories, less discomfort after-effect for patients, and fewer stages in the laboratory that could possible causes the impression process.[9,10,11]

Based on the scientific literature, the maximum range of marginal gaps that can be clinically accepted is 50 μm to 200 μm. At this time, many researchers are using the limit set by McLean dan Von Fraunhofer which is <120 μm. American Dental Association (ADA) specification no. 8 stated that the thickness of cement for the crown is around 25-40 μm so there

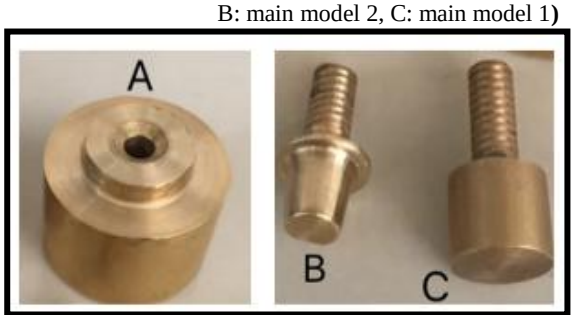
is no objective limit.[5,6,12] Seelbach et al (2013) researched the accuracy of conventional impression techniques and digital impression techniques. The result showed that the conventional impression of two-step putty–wash techniques showed more errors than the conventional impression one-step putty-wash technique. Digital impression technique provides the comparable result with conventional impression techniques, and fulfill the accuracy requirement for the transfer information process from patients to dentists in the dental laboratory. The research by Berrendero et al (2016) exposed no difference of marginal fit of the ceramic crown made by digital impression and conventional impressiontechniques. [13,14]

This study aims to find the differences amongmarginal of all-ceramic crownsobtained from one-step putty-wash, two-step putty-wash, and digital impressiontechniques.

II. Material And Methods

The design of this study was an experimental laboratory with a post-test of control group design. This study is using two main models made by alloys seated based on the main model(Figure 1a). The first main modelis used to make the physiological impression spoon with a diameter of 10 mm and a height of 8 mm to simulate the teeth before preparation(Figure 1c). The second main model is in diameter of 10 mm, the height of 6,5 mm, shoulder margin of 1,5 mm, consistency of 5º, and an angle of 30º (interlock) for the teeth simulate before the preparation(Figure 1b). The sample of this study is a cast modelobtained from conventional impression one-step putty-wash, two-step putty-wash with 9 samples each group, and 9 ceramic crowns from the digital impression technique.The sample fabrication site was conducted at the department of prosthodontics faculty of dentistry Universitas Sumatera Utara and for the measurement of marginal gaps at the biology laboratory faculty of mathematics and natural science UniversitasNegeri Medan.

Figure 1: Main model (A: basis main model, B: main model 2, C: main model 1**)**



Procedure Methodology

1. One-Step Putty-Wash Impression Technique

In the one-step putty-wash impression technique, the putty material and the wash material were put into the impression tray simultaneously and then placed on the main model 2 and wait until set about 2-3 minutes. After the impression material is set, the impression tray is removed from the main model 2 and left at room temperature for 30 minutes (Figure 2). After that, it is filled with dental stone type IVwith a ratio of 25 gr: 6 ml of water. The impression has waited until it set then released from the impression tray and then tidied it (Figure 3).

Figure 2. The impression of one-step putty-wash

Figure 3. Cast model of one-step putty-wash

2. Two-Step Putty-Wash Impression Technique

The two-step putty-wash technique, the putty material is mixed by hand and put on an impression tray. Then, the spacer is placed over the putty material as the space for wash material. Next, the impression tray is molded in main model 2 and wait until it is set. Finally, the impression tray is removed from the main model and let the putty material polymerize, along with the spacer sheet that is removed from the mold. The washed material is injected on top of the putty impression material so the impression is evenly distributed after, then put back on the main model 2. Following the impression tray set and removed from the main model 2 and let stand at room temperature for 30 minutes (Figure 4). Next, it is filled with the gypsum types IV with a ratio of 25 gr: 6 ml water. The result of the process is waited set, then removed from the impression tray, and be made up (Figure 5). Later, after getting the gypsum model form the one-step putty-wash and two-step putty-wash impression based on main model 1 and main model 1, it is sent to the laboratory for the ceramic crown with CAD/CAM system.

Figure 4. The impression of two-step putty-wash

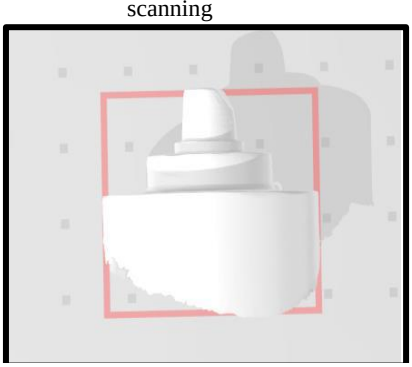
Figure 5. Cast model of a two-step putty-wash

3.Digital Impression Technique

The digital impression technique is using a direct scanning process for main model 2 with an intraoral *scanner* (TRIOS), then the result is sent to the laboratory for the impression of the ceramic crown with CAD/CAM system (Figure 6). The process of making the crown with a digital system begins with CAD (Computer-Aided Design) to design the ceramic crown with the computer, next is the process of CAM (Computer-Aided Manufacture) for designing the ceramic crown based on the computer to milling and sintering it. All stages in the laboratory for one-step putty-wash, two-step putty-wash,

and digital techniques were the same. The main model 1 was scanned to get a reference to the shape and size of the crown, while the main model 2 was for determining the design of a ceramic crown.

Figure 6. The result of intraoral scanning



The measurement is observed by stereomicroscope with 40x magnification. The measurement was made from the edge of the crown to the edge of the main model on 4 reference lines such as mid buccal (line A), mid mesial (line B), mid palatal/lingual (line C), and mid distal (line D) which each measurement was done three times, so the total of the measurement in one sample is 12 times. The data were analyzed using the Kruskal Wallis test to determine the differences of marginal fit in each ceramic crown.

III. Result

This study was conducted in three groups such as one-step putty-wash impression technique (group A), two-step putty-wash impression technique (group B), and digital impression technique (group C). Table 1 The results of this study indicate that the smallest marginal gaps are found in groups B and C 2.19 µm and the biggest marginal gaps value was found in group C, it was 13.03 µm. Group A shows the value of accuracy The smallest marginal gaps were 2.30 µm and the largest marginal gaps were 10.88 µm. The smallest marginal gaps in group B were 2.19 µm and the largest value was 4.03 µm. The smallest marginal gaps in groupC is 2.19 µm and the largest value is 13.03 µm.

Table 1: Marginal mean value of all-ceramic crowns gaps obtained from one-step putty-wash, two-step putty-wash, and digitalimpression techniques.

No. Sample	Marginal Gaps(µm)		
	Group A	Group B	Group C
1	4,19	2,88	7,49
2	3,12	3,41	13,03*
3	2,31**	2,84	12,77
4	10,88*	3,69	8,05
5	2,95	3,69	2.30
6	2,30	3,23	3.34
7	6,49	2,19**	4,26
8	2,65	3,46	2,19**
9	6	4,03*	3,80
$\bar{X}$ ± SD	4,54 ± 2,83	3,26 ± 0,55	6,35 ± 4,23

Note : **the smallest
* the biggest

The mean value of marginal gaps was analyzed by the Univariate test. Table 2. The mean of marginal fit of group A is 4,54 ± 2,83 µm, group B is 3,26 ± 0,55 µm and group C is 6,35 ± 4,23 µm. The result of the Kruskal Wallis test showed significant about p=0,31 > 0,05. This means that there are no differences found in the marginal fit.

Table 2: The differences among ceramic crown based on the marginal fit, obtained from one-step putty-wash, two-step putt-wash, and digital impression technique

Grop	*Marginal Fit* (µm)		
	n	$x^{\pm}$ sd	p
A	9	4,54 ± 2,83	0,31*
B	9	3,26 ± 0,55	
C	9	6,35 ± 4,23	

Note: *no significant

IV. Discussion

Marginal fit is one of the important things for the successful long term crown adaptation. Marginal adaptation could be measure by the gaps in crown marginal. The marginal gap is the quantitative value of distance (difference) between the edge of the crown and the dental limit preparation. 15 Poor marginal fit can lead to secondary caries, microleakage,

marginal discoloration, and dissolution of cement.[16]This study found that there are no significant differences among marginal fit in the ceramic crown obtained form one-step putty-wash, two-step putty-wash, and digital impression technique.

The study from Mclean dan Von Fraunhofer showed that marginal gaps around 120 μm could still be accepted for the permanent crown, which also applies to the temporary crown. However, the American Dental Association (ADA) specification no.8 stated that the cement thickness for the crown should not exceed 25 μm when using type I cement or not exceed 40 μm for type II cement. On this study, the marginal gaps mean for a ceramic crown obtainedfrom one-step putty-wash (4,54 μm), two-step putty-wash (3,26 μm), and digital (6,35 μm) impression technique, which the range of the result is very good or fit because the grade is very ideal (< 25 μm).

The result of this study is suitable for the study conducted by Berrendero S et al (2016) stated that there is no significant difference between the marginal fit of the ceramic crown obtainedfrom the digital impression technique and conventional impression technique. However, the study is contradicting the study mad by Seelbach et al (2013) and Syrek, et al (2010) showed that the ceramic crown made by ceramic crown is having a better marginal fit than conventional impression.[13,14, 17]

The mean difference in each group sample showed the lowest marginal gaps sequentially shown in two-step putty-wash, one-step putty-wash, and digital impression technique. The result of this study showed that marginal gaps of two-step putty-wash are lower than one-step putty-wash. This might be due to the two-step putty-wash impression technique which can control the thickness of wash material and it is not obtained from a one-step putty-wash impression technique.

In the one-step putty-wash impression technique, the part of the preparation margin impression by putty material often not detail in the impression the margin and the thickness of the wash material tend to uncontrolled which causes different dimensions in the result. Besides, there is a tendency of the air bubble formation in the one-step putty-wash technique compared to the two-step putty-wash technique. The result is suitable with the study from Caputi et al (2008) and Al-attaya et al (2018) about two-step putty-wash impression technique are more accurate than one-step putty-wash.[3,8,18,19]

The digital impression technique has bigger marginal gaps compared to the two-step putty-wash and one-step putty-wash impression technique. The digital impression has limitations such as data acquisition and processing, inaccurate calculation of CAD/CAM software, which causes large marginal gaps. [3,20] The size of cement space influences the ceramic crown too. Cement space that is too small can result in a margin of error from the CAM system in the milling stage in producing crowns which result in the difference of marginal gaps in each crown. The CAM system has limitations in cutting the block material in the restoration process which causes the decrease of internal precision and marginal fit. Al Attaya & Majeed (2018) stated that there is a limitation of the diameter and the shape of the milling instrument against the internal contours in the CAM system. If the cutting tool in the milling instrument is bigger than the prepared teeth, the system will have problems when cutting and forming the part, causing a decrease in the quality of internal fit and retention in the restoration.

V. Conclusion

Based on the research, it can be concluded that there is no significant difference of marginal fit of all-ceramic crown obtained from one-step putty-wash, two-step putty-wash, and digital impression technique, so it can be used clinically for getting a good mold.

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