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The Differences among Internal Fit of All Ceramic Crowns Obtained from One-Step Putty-Wash, Two-Step Putty-Wash and Digital Impression Techniques

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Abstract:
Background*: A full crown is a restoration that replaces part of the lost tooth structure and support the tooth structure. A full ceramic crown is the right choice for maximum aesthetic requirements. The prognosis of crown restoration one of them depends on internal fit because it is used to assess quality of crown restoration and adaptation. Crown adaptation is obtained from impression techniques namely conventional or digital impression technique. There are two conventional impression techniques for the treatment of fixed denture, namely one-step putty-wash and two-step putty-wash impression technique. The aim of this study is to find the differences among internal fit 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 experimental laboratory with posttest only control group design. The sample of this study are 20 cast model of one-step putty-wash and two-step putty-wash impression with 10 samples per group, and 10 ceramic crowns from digital impression so that the number of this study samples are 30 samples with three group. All samples used stereomicroscopes. Statistical analysis uses the One-way ANOVA test to determine the differences of internal fit all ceramic crown.* ***Results****: The results of this study showed that there were differences between groups with a value of p = 0.001 (p> 0.05). The LSD test showed a significant difference between the one-step putty-wash impression technique and the digital impression technique with p = 0,000 (p <0.05) and also between the two-step putty-wash impression technique and digital impression technique with a value of p = 0.012 (p <0.05).* ***Conclusion****: All ceramic crowns obtained from digital impression have the best internal fit because they produce the smallest internal gaps between the three groups.*
Key words: *Internal fit, all ceramic crown, one-step putty-wash, two-step putty-wash, CAD/CAM*

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I. Introduction

A full crown is a restoration that replaces part of the lost tooth structure and support the tooth structure. If the maximum aesthetic requirements and covering of all teeth must be required, then a full ceramic crown is the right choice.[1]The prognosis of crown restoration depends on internal fit as one of the main clinical factor because it is used to assess quality of crown restoration and adaptation. Study on internal fit is based on the measurement of the different points of the crown which can be divided into two parts, namely occlusal/ incisal and axial.[2,3] Internal fit depends on the value of the internal gaps. Poor internal gaps of coping can increase the thickness of the cement and thus influence the mechanical stability of dental restorations.[4]According to McLean (1971), ideal internal gaps range between 20 µm and 40 µm, but internal gaps ranges between 50 µm and 100 µm are still acceptable.[4] A restoration with a minimum internal gaps is a desirable aspect, since large internal gaps may adversely affect the retention or the resistance of the restoration.[5]

Internal fit related to crown adaptation which obtain from accurate impression.[6]An accurate impression can be achieved with either conventional or digital impression technique.[7] There are two conventional impression techniques recommended for fixed dentures, namely one-step putty-wash impression technique and two-step putty-wash impression techniques. The one-step putty-wash impression technique is a technique which uses putty material and wash material that are stirred together then placed on the prepared teeth, while the two-step putty-wash impression technique is a technique which uses putty material first then placed on the prepared teeth and leaving it to be set then adding the wash material on it and put the impression back on the prepared teeth.[8]

Studies have shown that many of the conventional dental impression that are sent to dental laboratories are unsatisfactory because of flaws such as voids or bubbles in critical locations.[9] Another impression technique that can be used to resolve these weakness is digital impression technique, since it can improve the efficiency of the treatment planning, improve the treatment documentation, potential cost and time effectiveness, and better communication between dentists and laboratories.[10]Yuzbasioglu et al (2014) explained that the efficiency outcomes of the digital impression technique were higher than conventional impression techniques with respect to treatment time taken up of the conventional techniques is longer.[11]Svanborg et al (2014) concluded that digital impression technique was more precise than conventional impressions using polyvinyl siloxane impression material. However, the fit of the restoration was good with the ratio of internal gaps in the cervical area are 44 μm for the digital and 69 μm for the conventional technique. In addition, it was found that all crowns produced with digital impression technique were easily seated on their corresponding study cast, whereas one crown produced with the conventional impression technique could not be seated on the study cast which may be caused by inaccurate impression.[3]

Al Atyaa&Majeed (2018) studied about comparative evaluation of the marginal and internal fitness of monolithic CAD/CAM zirconia crowns fabricated from different conventional impression techniques and digital impression using silicone replica technique. The result of this study revealed that the digital intraoral impression showed better marginal fit and internal fit than the conventional impression technique. However, there are limitations in the CAM system, the diameter and shape of the milling instrument against internal contours. If the cutting tool is larger in diameter than some parts of the tooth preparation, the system will face a problem of cutting and shaping the parts which consequently results in decreased internal fit precision and low retention of the restoration.[12]

Internal fit is one of the most important factors affecting the accuracy and long-term success of the fixed prostheses.[13] Poor internal adaptation can lead to lack of restoration retention and poor resistance form. Low dimension of internal fit and poor internal adaptation can cause higher compressive strength and decrease fracture resistance of restorations. This is the main cause of the restoration failure.[14]The minimization of internal gaps is one of the important goals in prosthodontic.[4] Though chairside CAD/CAM technology has advanced and very useful for patients and operators, there are still doubts regarding the marginal accuracy and internal fit of crowns produced with this technology when compared to conventional impression and laboratory produced crowns.[15]

The aim of this study is to find the differences among internal fit of all ceramic crownsobtained from one-step putty-wash, two-step putty-wash and digital impression techniques.

II. Material And Methods

The design of this study was experimental laboratory with posttest only control group design. This study used two main models made from alloys seated on the base of the main model (Figure 1a). The main model 1 has a diameter of 10 mm and a height of 8 mm to simulate unprepared tooth (Figure 1c) and the main model 2 has a diameter- 10 mm, height- 6.5 mm, shoulder margin- 1.5 mm, taper- 5º and angle- 30º to simulate prepared tooth (Figure 1b) .[16] The sample of this study were 20 cast model of one-step putty-wash and two-step putty-wash impression with 10 samples per group, and 10 ceramic crowns from digital impression. The sample size was determined by Federer's formula and obtained 30 samples divided into three groups with 10 samples each. The sample fabrication site was conducted at the department of prosthodontics faculty of dentistry Universitas Sumatera Utara and for the measurement of internal gaps at the biology laboratory faculty of mathematics and natural science Universitas Negeri Medan. This research was conducted in January-March 2020.

Figure 1. Main model (A: base of main model, B: main model 2, C: main model1)

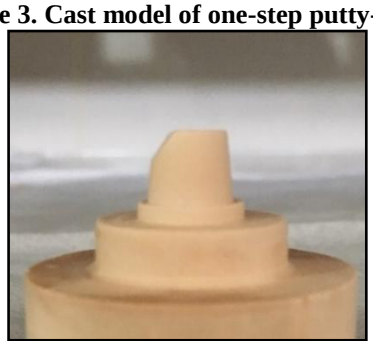
Procedure methodology

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 impressiontray simultaneously. At the same time, wash material is injected around the main model 2 as the prepared tooth. The impression tray that have been filled with impression material were placed on the main model 2 and wait until set about 2-3 minutes. After the materials were set, the impression traywas released from the main model and the impression was rinsed with water. The impressionwas left to set at room temperature for 30 minutes. After that, the impression was filled with dental stone type IV with a ratio of 25 gr: 6 ml of water. The impression was waited until it set then released from the impression tray and then tidied it up. After that, the main models 1 and 2 were sent to the laboratory to fabricate the ceramic crowns.

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

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



2. One-Step Putty-Wash Impression Technique

In the two-step putty-wash impression technique, the putty material was mixed by hand and placed first on the impression tray. Then the spacer was placed over the putty material as a space for the wash material. Then the impression traywas placed on the main model and wait until it set. After setting, the impression traywas removed from the main model and let the putty material polymerize and the spacer sheet can be removed from the impression. Wash material was put into dispensing gun and injected on top of the putty impression and on the main model so that the material was distributed well. Then the material was waited until it set for 2-3 minutes. After the materials were set, the impression traywas released from the main model and the impression was rinsed with water. The impressions were left to set at room temperature for 30 minutes. After that, the impression was filled with dental stone type IV with a ratio of 25 gr : 6 ml of water. The impression was waited until it set the released from the impression tray and then tidied it up. After that, the main models 1 and 2 were sent to the laboratory to fabricate the ceramic crowns.

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

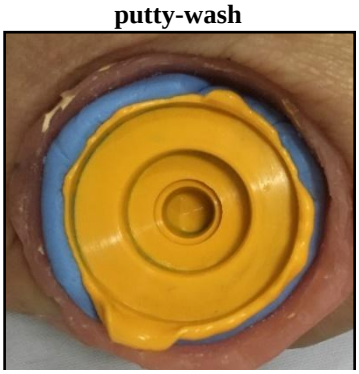
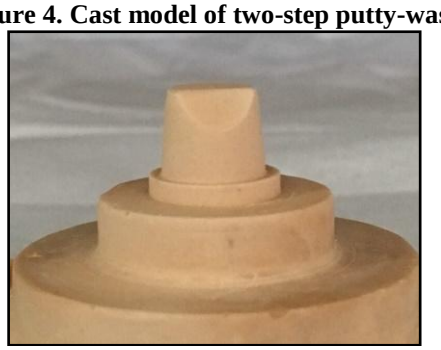


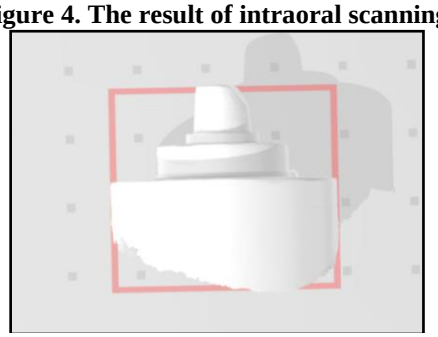
Figure 4. Cast model of two-step putty-wash



3. Digital Impression Technique

In the digital impression techniques, direct scanning was performed on the main model using an intraoral scanner, then the results of the scan were transferred directly to the software for the design and milling stages. 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. After that, proceed to the milling stage for 20 minutes and sintering for 10 hours with a peak temperature of 1500˚C to improve the structure and quality of the ceramic crown.

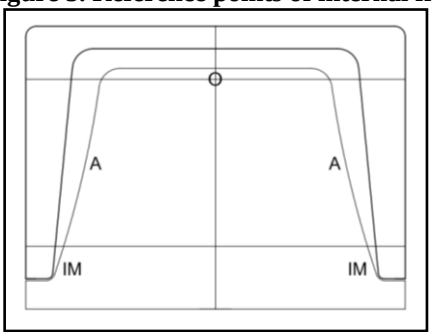
Figure 4. The result of intraoral scanning



4. Sample Measurement

Cross-sectional method was used to measure the internal fit of the crown by sectioning the ceramic crown in the direction of mesiodistal using a bur disk and then measured five reference points in three internal regions, two in the inner marginal region, two in the axial region and one in the occlusal region (Figure 2).[17] Measurements were made using a stereomicroscope with magnification 80x and each point was made 3 times. The total measurement in one sample was 15 times the measurement. Data analysis was tested using the one-way ANOVA test to determine differences among internal fit of all ceramic crowns obtained from each group.

Figure 5. Reference points of internal fit

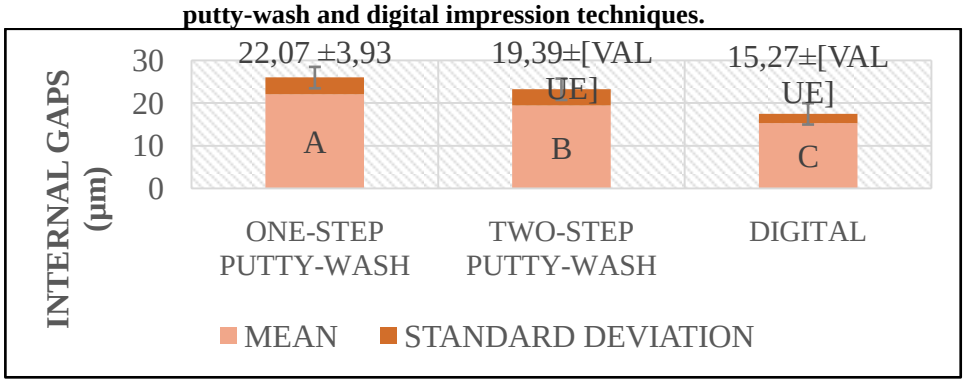


III. Result

This study consisted of three experimental groups, namely one-step putty-wash impression technique (group A), two-step putty-wash impression technique (group B) and digital impression technique (group C). This study was conducted to obtain internal gaps from the three groups. Measurements were made using a stereomicroscope to measure three internal regions with five reference points used, two in the inner marginal region, two in the axial region and one in the occlusal region.

The mean value of internal gaps in group A was 22.07 µm ± 3,93µm. The mean value of internal gaps in group B was 19,39 µm ± 3,87 µm. The mean value of internal gaps in group C was 15,27 µm ± 2,24 µm (Graph 1).

Graph 1. Mean internal gaps values of ceramic crownsobtained from one-step putty-wash, two-step putty-wash and digital impression techniques.



One-way ANOVA test results showed a significance of p = 0.001 <0.05. It showed that there are significant differences among internal fit of the three groups (Table 1).

Table 1. The differences among internal fit of all ceramic crowns obtained from one-step putty-wash, two-step putty-wash and digital impression techniques.

Groups	Internal gaps(µm)		
	n	$\bar{x}$ ± SD	P
A (One-step putty-wash)	10	22,07 ± 3,93	0,001*
B (Two-step putty-wash)	10	19,39 ± 3,87	
C (Digital)	10	15,27 ± 2,24	

Note: * significant

IV. Discussion

The differences among internal fit of all ceramic crown can occur due to several factors, including the design of the finish line, the selection of impression materials, the use of impression techniques, the accuracy of the impression, the selection of restoration material, cement space and fabrication procedures. In this study, several factors such as the design of the finish line, the selection of impression materials, restoration materials, cement space and fabrication procedures have been controlled.

The main factor that most influenced the results of this study was the accuracy of the impression according to the impression techniques used. The results of conventional impression techniques namely one-step putty-wash and two-step putty-wash have disadvantages such as the presence of porous or bubbles in critical

areas.9 This is likely to happen in the one-step putty-wash impression technique because of the putty and wash were uncontrolled so that the putty tends to push the wash of the prepared tooth and cause important areas such as margin could not to be printed in detail. In addition, the results of the one-step putty-wash impression technique tend to have bubbles or porous when compared to the two-step putty-wash impression technique.8 The two-step putty-wash impression technique has better impression results than the one-step putty-wash because of the spacer so that the wash material can be controlled. The results of this study indicate that the two-step putty-wash impression technique was better than the one-step putty-wash impression technique. This was similar with the research of Nissan et al (2000) which states that the two-step putty-wash impression technique was more accurate because there was room for polymerized wash.18

All ceramic crowns that obtained from digital impression technique has the best internal fit because this technique produced the smallest internal gaps among the three techniques. Restoration with a minimum internal gaps is desirable aspect because it provides better retention and resistance.7 However, clinically all ceramic crowns with an internal gaps below 20 µm will cause the crown to be misplaced when cemented on prepared tooth. All ceramic crowns that obtained from digital impression technique produced the smallest internal gaps because all the process of making crowns on digital techniques were done using computer system so that it saved time and minimized errors when impressing and fabricating crowns.

There were several opinions about the value of internal gaps that are clinically acceptable. According to McLean (1971), ideal internal gaps range between 20 µm and 40 µm, but internal gaps ranges between 50 µm and 100 µm are still acceptable.4 In this study, the mean internal gaps value of all ceramic crowns obtained from digital technique produced a smaller value (15,27 µm) compared to the other two groups, namely one-step putty-wash impression technique (22.07 µm) and two-step putty-wash impression technique (19,39 µm). Based on Mclean's theory, the values internal gaps of all ceramic crowns obtained from digital impression technique and two-step putty-wash impression technique were not within the ideal range (<20 µm).

In theory, restoration with minimum internal gaps is desirable because it provides better retention and resistance. But clinically, all ceramic crowns with internal gaps below the ideal internal gaps range (<20 µm) will cause the crown to be misplaced when cemented on prepared tooth.

V. Conclusion

All ceramic crowns obtained from digital impression technique produced smaller internal gaps compared to one-step putty-wash and two-step putty-wash impression techniques. Based on these results, it was concluded that all ceramic crowns obtained from digital impression technique has the best internal fit because they have the smallest internal gaps among the three techniques. However, clinically, all ceramic crown with internal gaps <20 µm will cause the crown to be misplaced when cemented on prepared tooth. Therefore, within the limitations of this study, one-step putty-wash impression technique was more recommended to gain a good position of the cemented crown, because it has an average internal gaps which were in the ideal range of 20 µm - 40 µm.

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