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Differences in Retention of Ceramic Crowns Using One-Step Putty-Wash, Two-Step Putty-Wash and Digital Impressions Techniques

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Abstract:
Background*: Crown is a permanently installed or cemented extra-coronal restoration that coats the outer surface of the clinical crown. The all ceramic crown produces a good and ideal aesthetic, a corresponding level of opacity and translucence, as well as a color that is not easily changed. Retention is considered one of the important factors in the adaptation of crown restoration. Crown retention and stabilization are also affected by internal gaps, internal adaptation ideally improving mechanical properties such as retention, strength and resistance. Crown adaptation is obtained from the impression results. There are two impression techniques, namely conventional impression techniques and digital impression techniques. There are two recommended conventional impression techniques, one-step putty-wash impression technique and two-step putty-wash impression technique. This study aims to find out the differences in retention of all ceramic crowns using one-step putty-wash impression techniques, two-step putty-wash and digital impression techniques.*
Materials and Methods*: The design of this study is experimental laboratory with posttest only control group design. Samples from this study were 30, one-step putty-wash impression group 10 samples, two-step putty-wash impression group 10 samples and digital impression group 10 samples. All samples are measured using Universal Testing Machine. Statistical analysis uses one-way ANOVA tests to determine the retention differences of all ceramic crowns.*
Results*: The results of study from the one-way ANOVA test showed no meaningful difference between the three groups with the value p=0.483 (p>0.05).*
Conclusion: *There is no difference between ceramic crowns made with one-step putty-wash impression, two-step putty-wash and digital, having equally good retention of all three groups.*
Key Word*: Retention, all ceramic crown, one-step putty-wash, two-step putty-wash, CAD/CAM*

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I. Introduction

A crown is a permanently installed or cemented extra-coronal restoration that coats the outer surface of a clinical crown. The all ceramic crown produces a good aesthetic and ideal, the appropriate level of opacity and translucence, the color is not easily changed. All ceramic crowns generally have fragile properties and are easily broken when receiving high chewing loads.[1] In recent decades, ceramic crowns have become increasingly popular and rapidly growing such as zirconia which has good strength, aesthetics, biocompatibility and can be produced with CAD/CAM system resulting in accurate mock crowns and shorter time.[2]

Retention is considered one of the important factors in the adaptation of crown restoration. According to Narulla (2011), retention is the resistance of dentures to the shifting force that causes movement in the opposite direction/dislodgement with the direction of the pair so that it will result in the dentures staying in position, as wellas stability is the ability of the denture to remain stable in its position when used. The lack of denture stability often makes retention and support factors on the teeth ineffective.[3]

Retention and stabilization of crowns is also influenced by internal gaps, where minimum internal gaps are a desirable aspect of a restoration because large internal gaps and not homogen can reduce restoration retention.[4] Internal adaptation ideally improves mechanical properties such as retention, strength and resistance. Restoration adaptation is determined by the measurement value of internal gaps, which is one of the important factors for the long-termsuccess of restoration.[4,5]

The success of a crown really depends on the impression stage used, where an accurate impression will produce a good adapted crown. There are two impression techniques that can be used for crown making, namely conventional impression techniques and digital impression techniques. The recommended conventional impression techniques are one-step putty-wash impression technique and two-step putty-wash impression technique.

One-step putty-wash impression technique is impression with putty material and wash material stirred simultaneously then placed on the prepared buffer gear, while the two-step putty-wash impression technique is impression with putty material made first and left setting then the wash material is added and the mold is re-inserted. [6,7] Another impression technique that can be used to overcome the shortcomings of conventional impression techniques is digital impression techniques. On digital impression the data is taken directly from the patient's mouth using an intraoral scanner, after which the utilization of design and manufacturing with the help of a computer (CAD/CAM). The advantages of digital impression include more efficient use of time compared to conventional impression and producing better, more accurate prints and more convenient processes for patients.[8]

Seelbach et al (2013) the results of the study can be concluded that most conventional two-step putty-wash impression techniques show greater errors than conventional one-step putty-wash impression techniques. As seen from the mold distortion during the wash impression step, the material impression is distorted so that an error occurs in the dimensions of the mold.[9] Chugh et al (2012) two-step putty-wash technique with uniform and controlled wash space is recommended for the manufacture of stone models that will result in proper restoration.[10] Gabor et al (2017), the use of digital impression techniques can eliminate all the risk of errors that occur when using conventional impression techniques. The study shows the success rate in digital techniques is higher than conventional.[11]

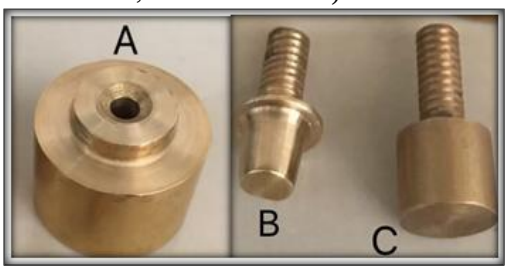
Layla et al (2018), conducted a study with the aim of evaluating the strength of the zirconia crown retreat attached with two types of resin cement under changes in environmental pressure with a preparatory wall of 6^o-12^o. The conclusion of the study is that resin cement can affect the retention strength of zircon crowns. [12]

This study aims to find out the differences in retention of all ceramic crowns using one-step putty-wash impression techniques, two-step putty-wash impression techniques 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 alloy (copper alloy and zinc metal) seated on the base of the main model with a diameter of 30 mm, height 25 mm and made edges at the top with a diameter of 6 mm (Figure 1a). The main model 1 has a diameter of 10 mm, height of 6.5 mm, shoulder margin of 1.5 mm, taper 5^o and an angle of 30^o (interlock) to simulate the prepared tooth (Figure 1b) and the main model 2 has a diameter of 10 mm, height of 8 mm to simulate unprepared tooth (Figure 1c).[13] In this study the minimum sample count was estimated based on Federer's formula and the total sample was 30, 10 cast model samples one-step putty-wash impression techniques, 10 cast model samples two-step putty-wash impression techniques and 10 ceramic crown samples digital impression techniques. The sample making and sample measurement was conducted at the Research Laboratory of the Department of Prosthodontics FKG USU. This study was conducted in January–March 2020.

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



Procedure methodology

1. One-Step Putty-Wash Impression Technique

In one-step impression techniques, the putty materials are manipulated by hand and placed on a impression tray. Then the wash material is injected on a impression tray which already contains putty material and wash material injected around the main model 2 to print evenly (Figure 2). The impression tray that has been filled with putty and wash material were placed on the main model 2 and wait until it were set for 2-3 minutes, after material were set the impression tray is removed from the main model then rinsed with water and let stand at room temperature for 30 minutes (Figure 3). After that the mold is filled with dental stone type IV with a ratio of 25 gr: 6 ml of water. The impression is left were set and the cast model is removed from the impression tray and groomed (Figure 4). Furthermore, the main models 1 and 2 are sent to the laboratory for the manufacture of ceramic crowns.

Figure 2. One-step impression (A: The wash material injected on top of the putty material; B: The wash material injected into main model)

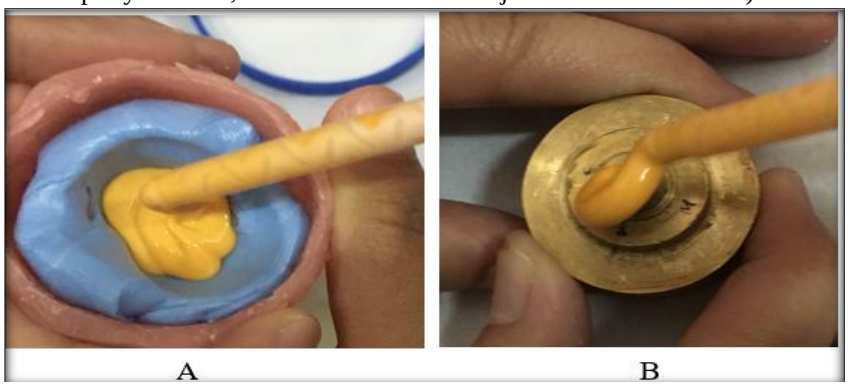


Figure 3. The one-step impression putty-wash

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

2. Two-Step Putty-Wash Impression Technique

In the two-step impression technique, putty material was manipulated 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 tray was place on the main model and waited until it set. After material setting, spacer taken and injected wash material on top the putty impression and around the main model 2 then re-mold and wait until it set for 2-3 minutes (Figure 5). After material were set the impression tray is removed from the main model then rinsed with water and let stand at room temperature for 30 minutes (Figure 6). After that the mold is filled with dental stone type IV with a ratio of 25 gr: 6 ml of water. The result of the mold is left until hardened and then the cast model is removed from the impression tray and spruced up. Furthermore, the main models 1 and 2 are sent to the laboratory for the manufacture of ceramic crowns (Figure 7).

Figure 5. Two-step impression (A: Inject wash material over putty material; B: Also inject on top of main model)

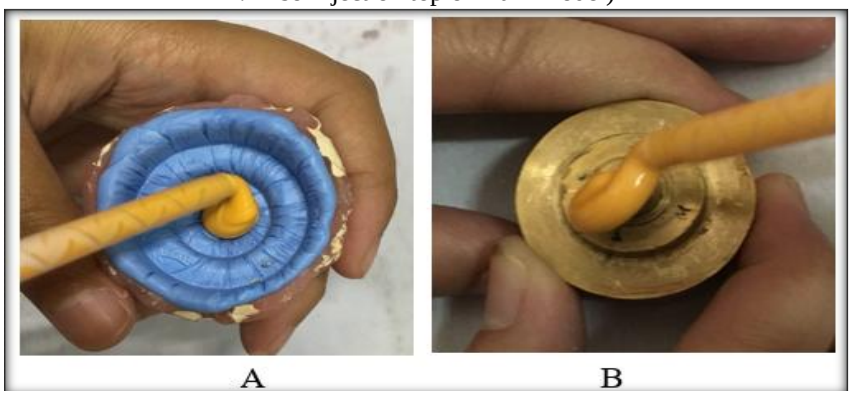


Figure 6. The one-step impression putty-wash

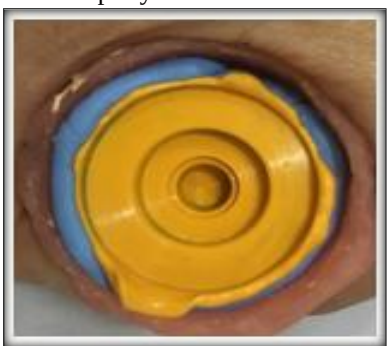


Figure 7. Cast model of two-step putty-wash

3. Digital Impression Technique

In digital impression techniques, the main model is scanned using an intraoral scanner (TRIOS) (Figure 8), the result of the file is processed to the next stage of making the design with CAD / CAM and continued the milling process. 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 9). After the crown is completed in milling proceed to the sintering stage for 10 hours with a peak temperature of 1500^{o}C which aims to improve the structure of the ceramic crown.

Figure 8. The result of intraoral Scanning

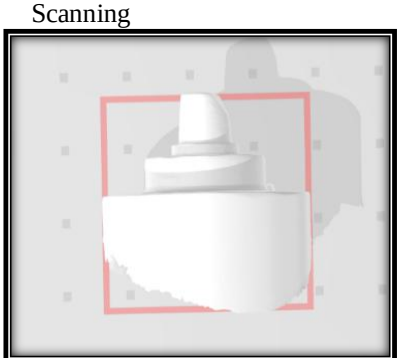
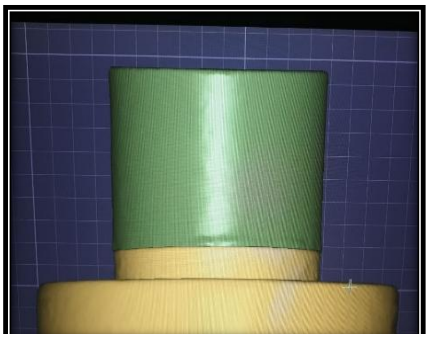


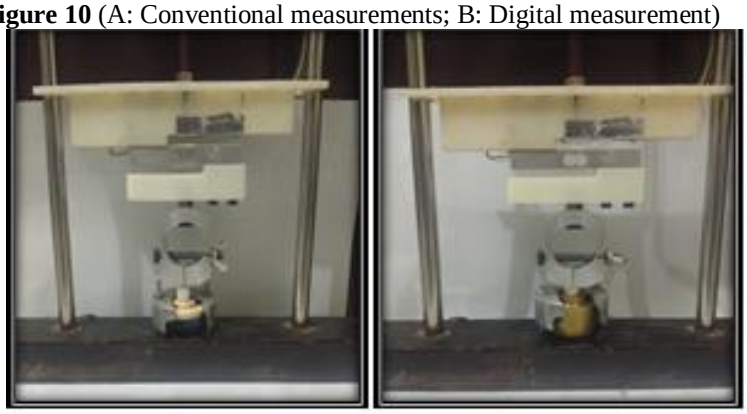
Figure 9. Design of a ceramic crown



4. Sample Measurement

Measurement using universal testing machine. Measurements are performed based on impression techniques, one-step putty-wash and two-step putty-wash impression using a working model (Fig 10a) and digital impression using main model 2 (Fig 10b), the working model and main model 2 are attached to the brackets on the bottom side and the hooks of the tool squeeze the crown and lock tightly. After that, the tensile test is carried out until the crown is slowly detached from the working model and main model 2. The resulting load data is then observed and recorded.

Figure 10 (A: Conventional measurements; B: Digital measurement)



III. Result

In this study there were three groups, namely one-step putty-wash impression technique (Group A), two-step putty-wash impression technique (Group B) and digital impression technique (Group C). The study was conducted to obtain retention scores generated from all three groups using the Universal Testing Machine. The average retention value in group A is 26.44 N with a standard deviation of 15.25 N, group B is 35.20 N with a standard deviation of 19.68 N and group C is 35.03 N with a standard deviation of 19.68 N (Graph 1). One-way ANOVA test results obtained a value of p=0.483 (p>0.05) which means there is no retention difference between the three impression techniques (Table 1).

Graph 1. Mean retention of ceramic crowns using one-step putty-wash, two-step putty-wash and digital impressions techniques.

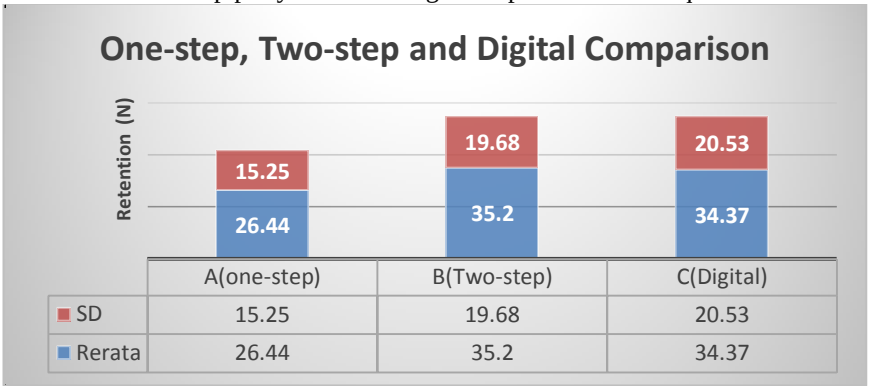


Table 1. The differences in retention of ceramic crowns using one-step putty-wash, two-step putty-wash and digital impressions techniques.

Group	Retention (N)		
	n	$\bar{x}$ ± SD	p
A	10	26,44 ± 15,25	0,483
B	10	35,20 ± 19,68	
C	10	35,03 ± 19,68	

IV. Discussion

Differences in the retention of ceramic crowns can occur due to several factors, including the resulting preparation, freedom of displacement or geometry preparation, the magnitude of dislodging forces, type of luting agent, cement space, roughness of the internal surface of dentures/fitting surfaces, segmented materials and impression techniques.[3] In this study, several factors have been controlled such as the resulting preparation, geometry preparation, the magnitude of dislodging forces, cement space using the smallest value of 20 µm, and the roughness of the internal surface of dentures/fitting surface that is the crown zircon.

The factor that most influenced the results of this study was the accuracy of the printouts of the impression techniques used. In this study, polyvinyl siloxane impression materials were used for impression that has been reported as accurate impression material and the most stable in dimensions.[14] The results of this study showed that the two-step putty-wash impression technique is better than the one-step putty-wash impression technique. In one-step putty impression-wash is often the part of the preparation margin printed by the putty material is not detailed in impression the margin and thickness of the wash material tends to be uncontrolled which can result in a change in dimensions. In addition, in one-step putty-wash impression there is a tendency to the formation of air bubbles in the mold when compared to the impression of two-step putty-wash.[6] This is in accordance with the research of Nissan et al (2000), which states that the two-step putty-wash impression technique is more accurate because there is room for polymerized wash and Chugh et al (2012), which states that two-step putty-wash impression techniques with controlled wash space are recommended for the manufacture of stone models because they can produce accurate restoration.[10]

Digital impression techniques have a small retention value compared to the two-step putty-wash technique. Digital impression has limitations such as acquisition and data processing, improper calculation of CAD/CAM software causing large gaps.[15] The size of cement space has an influence on the adaptation of ceramic crowns. Too small cement space can result in the margin of error of the CAM system at the milling stage in producing crowns resulting in different retention values of each crown. The CAM system has

limitations when cutting block materials on the restoration section resulting in a decrease in internal precision.[16] Al Attaya & Majeed (2018), states that there are limitations in the CAM process in terms of diameter and shape of milling instruments against internal contours. If the cutting tool on the milling instrument is larger than the preparation gear, then the system will have problems cutting and forming the part causing a decrease in marginal fit quality, internal fit and retention on restoration.[15]

Impression techniques are also closely related to the geometric configuration of a preparation. Deft dentures depend on the geometric shape of the preparation rather than adhesion to retention. The correct shape of the preparation will result in retentive dentures when the impression is also correct. The results of a study conducted by Jeison et al (2016), showed impression made with intraoral scanners was significantly more accurate than that of the impression group using polyvinyl siloxane with a total angle of occlusal convergence (TOC) of less than $8^{o.}$ conventional gear impression followed by scanning using extra-oral digital cannot produce dental preparation properly if the TOC angle is close to $0^{o.}$ In contrast, digital impression with intraoral scanning can accurately print dental preparations well from its geometry.[17]

In this study, ceramic crown samples were not cemented because accurate preparation and impression can result in retention. Measurements of ceramic crown retention before and after cementing affect measurement results. Some previous studies have reported pre-cemented retention values. Kaufman (1996), reported restoration without cement on the mold and found high variations in values that had a small negative correlation with cemented retention. Lorey and Myers, note that there is no relationship between the un-cemented denture retention value of various designs and the retention value after cementation. Marker (1996), found no correlation between friction load retention without cement and retention after cementing. They note that 70% of restorations without cement space show measurable friction retention and have a much lower retention value when cemented. The results showed that increased retention of cementation is not an indicator of adequate peg retention.[18]

V. Conclusion

Based on the results of the study, it can be concluded that there is no significant difference between the retention of ceramic crowns made with one-step putty-wash impression techniques, two-step putty-wash and digital impression techniques, but clinically the impression techniques of all three can be used to obtain good print results.

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