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RESEARCH ARTICLE

MARGINAL ACCURACY OF METALLIC COPINGS FABRICATED BY DIFFERENT WAX PATTERN TECHNIQUES

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ABSTRACT

Objectives: To evaluate marginal accuracy of metallic copings fabricated by conventional lost wax, CAD CAM technique using stereomicroscope. **Methods:** A stainless steel die was used with preparation height of 7 mm., finish line of 1.0 and the axial convergence was 5 degrees. Seven polyether impressions of the die were made and poured to extra hard stone to produce dies. Upon each die two types of wax pattern were fabricated, Group I: copings were fabricated manually. Group II: copings were fabricated using Cercon CAD/CAM machine creating 30 copings from the two groups (15 each group). All wax patterns were invested and casted to Nickel-chromium alloy Marginal gap was tested on 4 points around the copings using stereomicroscope. Paired t-test was used to analyze data P value lower than 0.05 considered statistically significant. **Results:** there was statistically significant difference between tested groups, The mean (SD) for the marginal gap were 109.85(24.71), 115.97 (25.65) for manual and CAD/CAM fabricated wax patterns respectively. **Conclusion:** With the limitations of this study, the conventional fabricated wax patterns (group I) gives significantly better marginal gap than CAD/CAM (machine-milled) technique (group II).

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INTRODUCTION

The processes of crown or coping fabrication require waxing up of the prepared die and building the contour and morphology .Wax patterns that are built up manually may have some sort of error and variation depending on the technician skills. in recent years, Different techniques are used to fabricate wax patterns either machinably or manually then restorations can be obtained, Computer-aided design/ computer-aided manufacturing (CAD/CAM) is the least technique that depend on the skills of the laboratory technician (Strub, 2006) Cercon is CAD CAM machine that fabricates crowns, copings, frameworks and full anatomical all-ceramic restorations as well as resin and wax copings. One of the successful requirement of ideal crown is marginal. Excellent marginal fit of crowns will decrease plaque accumulation and occurrences of periodontal diseases leading to clinical success (Komine *et al*., 2007). An acceptable marginal gap for ceramic restorations should be less than 120µm (Att *et al*., 2009). Marginal fit more than 120µm may lead to plaque buildup, dissolution of luting cements, caries, pulp inflammation, and periodontal disease (Beschnidt, 1999) In 2016 vitro study was conducted tocompare the internal fit of single crowns produced with the lost-wax and metal casting technique with that of single crowns produced with the CAD-CAM technique. The study reveal that the internal gaps in mesio-distal and buccal-palatinal directions were statistically smaller for crowns made by conventional lost-wax and metal casting technique compared to crowns produced by CAD/CAM technique (Dahl, 2017). In 2013, in virto study was conducted to compares the marginal and internal fit of copings cast from CAD/CAM and conventional fabricated wax-patterns.the study shows that conventional method of wax-pattern fabrication produced copings with significantly better marginal and internal fit than CAD/CAM (machine-milled) technique. All the factors for 2 groups were standardized except wax pattern fabrication technique, therefore, only the conventional group results in copings with clinically acceptable margins of less than 120um (Vojdani *et al*., 2013).

In vitro study was conducted in 2015 to evaluate the maximum and minimum distances between the model and the cast crown of three techniques of wax pattern using Scanning Electron Microscopy**.** The study reveals that there was no statistical significance among groups A, B, and C ($p = 0.174$). The marginal adaptations of all three techniques were within a reported clinically acceptable range of margin (Alan Sepulveda-Rodríguez, 2015)

MATERIALS AND METHODS

A stainless steel die was prepared using engineering lathe (Automatic feedback lathe- BV20B-L Bengu Dome Siticmaxhime tool, China) with preparation height of 7 mm. with occlusal notch to prevent crown rotation, a uniform heavy shoulder finish line of 1.0 mm in width, and the axial convergence was 5 degrees (Figure 1) (Rastogi, 2011). Seven impressions of the die were made with polyether impression material (Impregum Penta; 3M ESPE, USA), impressions and poured using extra hard stone (bego, Germany) using the manufacturer's recommended water/powder ratio to produce stone dies, these dies were subsequently used for manufacturing of wax patterns. Upon each 15 dies two types of wax pattern were fabricated (15 dies fabricating group I)and the same dies (15dies fabricating group II) to ensure that all subjects are standardized(the total number of fabricated wax copings is 30), Group I : crowns were fabricated manually . Group II: crowns were fabricated using Cercon CAD/CAM machine (Degudent GmbH, Hanau, Germany). For group I, wax patterns were fabricated manually on dies. For group B, working dies were sprayed by Cercon scan spray (Degudent GmbH, Hanau, Germany), to be easily scanned by Cercon scanner (Cercon EYE) (Figure 2). The virtual cement thickness was set as 30 µm, Spacer coverage was 90% spacer coverage corresponding to approximately 0.5 mm off the finish line as suggested by the manufacturer (Figure 3). Type of restoration was set to be copings. Designed restorations were sent to Cercon Brain using flash memory card, then (wax discs,) were milled using a CAM system (Cercon Brain) (Figure 4). Sprues were attached to all fabricated wax patterns (manually and CAD/CAM fabricated), suitable size casting ring was chosen and placed over crucible former. Investment of the ring was done using phosphate bonded investment. casting ring was placed inside the oven for two and a half hours. Nickel-chromium alloy (Wiron 99, BEGO, Germany) was introduced in the ring to produce crowns. All crowns (group I and group II) were checked for seating on their corresponding dies and any nodules were removed before measurements. Marginal gap was tested on 4 points around the crowns using stereomicroscope (EMZ-13TRD, Meiji techno,Japan) (Figure 6) The casted samples were individually set to the master die and capturing the 4 images for each die and measure the gap in (µm). Statistical Package for the Social Sciences (SPSS) was used to enter and analyze data.

RESULTS

Mean, standard deviations of measured gap for both groups were shown in table1.Mean ± standard deviationin (µm) is 109.85(24.71), 115.97 (25.56) in groups I and II, respectively (table1). ($p > 0.05$). However, the Unpaired t test score is (-3.375) which indicate that there is statistically significance difference in marginal gap between groups I and II ($p=0.02$) (table 1). (Figure7):

Figure 1. Standardized metallic die used in the study

Figure 2. Die was scanned by CERCON scanner

Figure 3. Designing of the die on Cercon machine

Figure 4. Manufactured wax patterns in the casting ring before investment

Figure 5. Casted crowns before removing of sprues

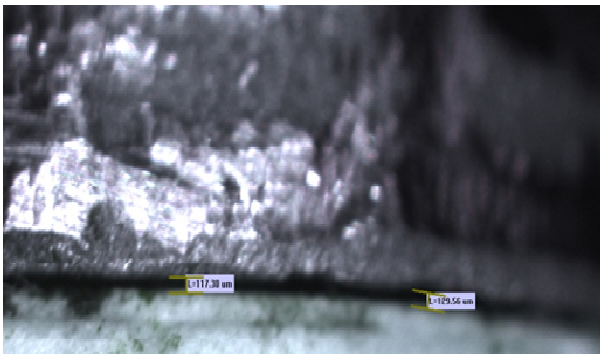

Figure 6. Measurementsof marginal gap using microscop

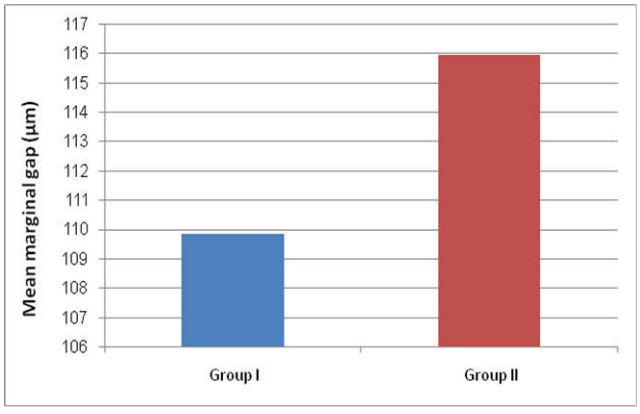

Figure 7. Histogram showing mean marginal gap of conventional wax technique (group I) and CAD CAM wax technique (group II)

Table 1. Mean marginal gap of group I and group II.

Group	Name	Mean (SD)	*P* value
Group I	Conventional wax pattern	109.85(24.71)	0.02
Group II	CAD CAM wax pattern	115.97 (25.56)	0.02

DISCUSSION

Previous studies showed that both light microscopy measurement techniques and scanning electron microscope (SEM) imaging and can be used to measure marginal adaptation (Beschnidt, 1999; Dahl, 2017; Vojdani, 2013; Alan Sepulveda-Rodríguez, 2015; Rastogi, 2011; Groten et al., 2008) since there was no significant difference between the accuracy of the two techniques. Measurement of marginal fit Without sectioning specimens was examined under light microscope in the vertical plane because it is non-destructive, rapid, easy and convenient method, even though horizontal and internal measurements are more accurate information on the 3-dimensional changes of marginal integrity but comparison of margin after different cycles will be difficult as internal measurements require cross-sectioning the crowns. There is controversy opinions regarding acceptable marginal fit. Theoretically, cement film thickness should be ranged from 20 to 40 microns (McLean, 1971). Marginal fit was different according to different materials and different fabrication techniques but it ranges from 17 µm to 161 µm (Tan *et al*., 2008). Moldovan *et al*. rated the values of 100 um for marginal misfit as good and values of 200–300 um as acceptable (Moldovan, 2006) the amount of marginal discrepancies of conventional group are within the clinically acceptable range of 120um (Groten, 2008). Therefore, the marginal accuracies, represented by the absolute marginal discrepancy and measured in the present study, could be rated as good for both groups. The results in this study was in agreement with previous studies (Gj.c 1966; Baig, et al., 2010).

Also which all reported the prominence of conventional method of metal copings fabrication than CAD/CAM fabricated restoration, due to marginal and/or internal fit. the investigators reported that conventional wax-up and casting technique produced better marginal fit than CAD/CAM technique for fabricating titanium crowns Gj.c 1966; Han *et al.,* 2011). It has been demonstrated that marginal fit is significantly dependent on the CAD/CAM system used (Kohorst *et al*., 2009).

There is one similar aspect between all of these studies, that they use subtractive method to fabricate the restorations, out of an industrially prefabricated solid block of ceramic or titanium. However, Shamseddine *et al* stated that marginal gaps of the pressed crowns made from wax CAD-CAM manufacturing was significantly lesser than that of the conventionally waxed up crown This result may bedue to presences of small defects in the manual waxing up caused by the wax pattern's color and glossy surface which is difficult to be identified (Shamseddine *et al*., 2016; Rosenstiel *et al*., 2016) from conventional and computer-aided design and computer-aided manufacturing wax patterns. There are some limitations in this study. Marginal fits of copings after cementation were not determined and there is no thermal cyclingas Thermal cycling is one of the important factors that affect the long-term marginal fit of crown Also all coping were produced and tested under ideal conditions, which may not reflect conditions in daily clinical practice.

Conclusion

With the limitations of this study, the conventional fabricated wax patterns (group I) with significantly better marginal accuracy than CAD/CAM (machine-milled) technique (group II). All the factors for 2 groups were standardized except wax pattern fabrication technique. The use of conventional wax pattern gave better adaptation of copings than that machinable fabricated. further investigations are needed to include more types of restorations with different measuring methods and under different condition that reflect the oral environment.

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