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Marginal and internal fit of metal copings cast from wax patterns fabricated by CAD/CAM and conventional wax up techniques

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Abstract
Background: Wax patterns are fabricated with wax using particular waxing instruments in conventional techniques. The present study was conducted to compare marginal and internal fit of metal copings cast from wax patterns fabricated by CAD/CAM and conventional wax up techniques.
Materials & Methods: 30 standardized brass dies were randomly divided into 2 groups according to the wax-patterns fabrication method. Group I comprised CAD/CAM technique and group II conventional method. Each group comprised of 15 dies.
Results: Marginal gap in group I was 145.2 µm and in group II was 72.6 µm, absolute marginal discrepancy in group I was 215.7 µm and in group II was 90.4 µm, internal gap axial in group I was 82.4 µm and in group II was 61.2 µm, internal gap occlusal in group I was 192.4 µm and in group II was 120.5 µm and internal gap total in group I was 112.6 µm in group II was 74.2 µm. The difference between both groups was significant (P< 0.05).
Conclusion: Conventional method of wax-pattern fabrication produced copings with significantly better marginal and internal fit than CAD/CAM (machine-milled) technique.

Keywords: CAD/CAM, conventional wax up techniques, Metal coping

Introduction
Wax patterns are fabricated with wax using particular waxing instruments in conventional techniques [1]. Rationale for choosing wax is that, it can be manipulated and shaped according to preferences and can also be completely eliminated from the mold by heating. Among the various steps of making the porcelain fused-metal crown, fabrication of the wax pattern is the most analytical, effortful and time-consuming step [2]. Also, the wax-up's quality is dependent on the skill of the individual doing it. Previous research states that removing a wax pattern from a die with a shoulder margin causes an average of 35µm opening of the margin before investing [3]. Wax has various integral restrains such as, fineness, thermal sensitivity, elastic memory and a high coefficient of thermal expansion. Also, the wax pattern's colour and glossy surface makes it difficult to identify minute defects [4].
Conventionally, wax patterns were fabricated with wax and waxing instruments for example the popular PKT instruments. Wax is used to make the patterns because it can be conveniently manipulated, precisely shaped and can also be completely eliminated from the mold by heating [5]. With different CAD/CAM systems, it is possible to fabricate the wax patterns made from castable materials and omit several limitations of conventional wax-up technique. CORiTEC, Precident DCS system and Everest system are among the CAD/CAM systems that have the ability to mill frameworks made from castable acrylic [6]. The present study was conducted to compare marginal and internal fit of metal copings cast from wax patterns fabricated by CAD/CAM and conventional wax up techniques.

Materials & Methods
The present *in vitro* laboratory study comprised of 30 standardized brass dies. This study got approval from ethical committee.

After preparing brass dies, they were randomly divided into 2 groups according to the wax-patterns fabrication method. Group I comprised CAD/CAM technique and group II conventional method. Each group comprised of 15 dies. All the wax-patterns were fabricated in a standard fashion by means of contour, thickness and internal relief. M1- M12 were representative of CAD/CAM group I and C1-C12 were representative of conventional group II. CAD/CAM milling machine was used to fabricate the CAD/CAM group wax-patterns. The copings cast from 24 wax-patterns were cemented to the corresponding dies. Cross-sectional technique was used to assess the marginal and internal fit for all the coping-die assemblies at 15 points. Chi- square test at the value of 0.05 was considered significant.

Results

Table 1: Distribution of dies

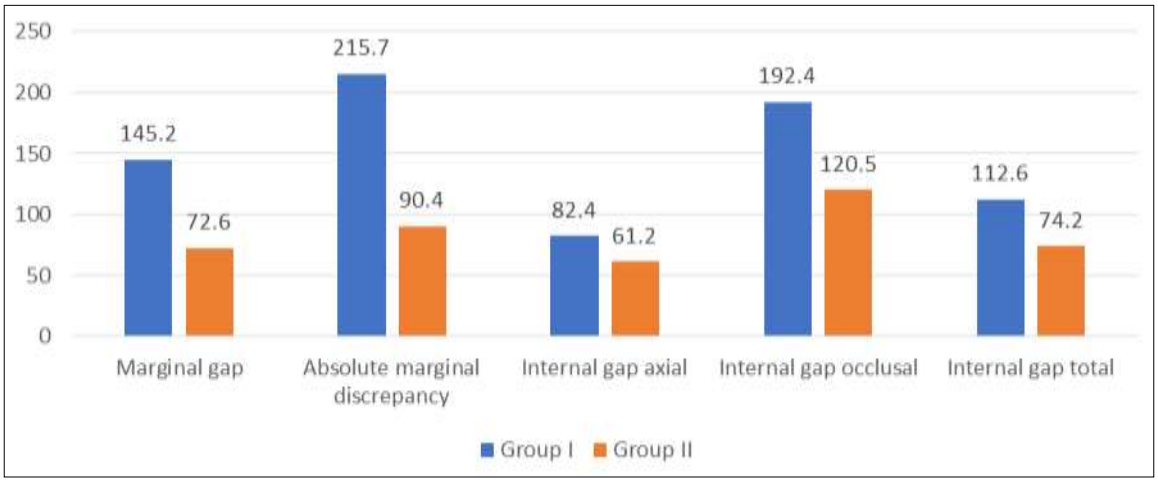
Groups	Group I	Group II
Method	CAD/CAM	Conventional method
No. of dies	15	15

Table I shows division of brass dies based on the wax-patterns fabrication method used.

Table 2: Comparison of parameters in both groups

Parameters (µm)	Group I	Group II	P value
Marginal gap	145.2	72.6	0.01
Absolute marginal discrepancy	215.7	90.4	0.02
Internal gap axial	82.4	61.2	0.05
Internal gap occlusal	192.4	120.5	0.04
Internal gap total	112.6	74.2	0.01

Table II, graph I shows that marginal gap in group I was 145.2 µm and in group II was 72.6 µm, absolute marginal discrepancy in group I was 215.7 µm and in group II was 90.4 µm, internal gap axial in group I was 82.4 µm and in group II was 61.2 µm, internal gap occlusal in group I was 192.4 µm and in group II was 120.5 µm and internal gap total in group I was 112.6 µm in group II was 74.2 µm. The difference between both groups was significant (P< 0.05).



Graph 1: Comparison of parameters in both groups

Discussion

CAD/CAM technology has become a major revolution in modern dentistry and represents the most innovative approach. It is considered as an advancement over conventional dentistry as it allows extremely precise designs and good quality restorations [7]. Today, due to the availability of various CAD/CAM systems, it is possible to fabricate the wax patterns made from castable materials, avoiding above stated limitations of wax and conventional wax-up technique. The reduction of marginal gap to a minimum in crowns and fixed partial dentures is a key goal in prosthodontics [8]. Minimal marginal gaps reduce gingival irritation and cement washout thereby improving clinical outcome and longevity of restoration. Good marginal fit is one of the most important technical factors for long term success of metal ceramic crowns and this depends on good internal fit [9]. The present study was conducted to compare marginal and internal fit of metal copings cast from wax patterns fabricated by CAD/CAM and conventional wax up techniques.

In present study, Group I used CAD/CAM technique and group II used conventional method for wax-patterns fabrication. Each group comprised of 15 dies. Chnadrika *et al*. [10] compared the marginal gap of metal copings cast from wax patterns fabricated with conventional technique and CAD/CAM technique. Fifty samples were fabricated using Standardized MIS implant abutment as a die. 25 wax patterns (n=25) were fabricated by conventional wax coping method and rest (n=25) were fabricated by CAD/CAM wax milling technique. The wax copings of both the methods are casted with conventional casting technique. The marginal gap of copings was evaluated by direct view technique under stereomicroscope (MAGNUS) with digital camera. Then images were transferred to personal computer for measuring marginal gap at 15 random points by using image analyzer. This study showed an overall mean of 595.26 µm for absolute marginal discrepancy (AMD) with Standard deviation of 264.94 for CAD/CAM group and 233.42 um with Standard deviation of 184.98 for conventional group (control). The marginal gap was significantly higher in CAD CAM group than the conventional wax-up group.

We found that marginal gap in group I was 145.2 and in group II was 72.6, absolute marginal discrepancy in group I

was 215.7 and in group II was 90.4, internal gap axial in group I was 82.4 and in group II was 61.2, internal gap occlusal in group I was 192.4 and in group II was 120.5 and internal gap total in group I was 112.6 in group II was 74.2. Vojdani *et al*. [11] compared the marginal and internal fit of copings cast from CAD/CAM and conventional fabricated wax-patterns. Twenty-four standardized brass dies were prepared and divided into 2 groups ie. CAD/CAM technique and conventional method (n=12). The overall mean (SD) for absolute marginal discrepancy (AMD) was 254.46 (25.10) µm for CAD/CAM group and 88.08(10.67) µm for conventional group (control). The overall mean of internal gap total (IGT) was 110.77(5.92) µm for CAD/CAM group and 76.90 (10.17) µm for conventional group. The Student's t-test revealed significant differences between 2 groups. Marginal and internal gaps were found to be significantly higher at all measured areas in CAD/CAM group than conventional group ($p < 0.001$).

Valderrama *et al*. [12] reported the overall marginal discrepancies of 61±34µm for titanium metal ceramic crowns fabricated with CAD/CAM system and 47±17µm for the gold platinum-palladium metal ceramic crowns fabricated with conventional methods; although there were no statistical differences between the two groups.

Conclusion

Authors found that conventional method of wax-pattern fabrication produced copings with significantly better marginal and internal fit than CAD/CAM (machine-milled) technique.

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