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A comparative assessment for marginal fit of fixed dental prostheses using conventional and digital impression techniques – An In-vitro study.

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Abstract

Introduction**:** Once DeVan quoted that: "Perpetual preservation of what remains is more important than the meticulous replacement of what is missing" it still rings true. The major factor affecting the longevity of the fixed dental prosthesis is marginal integrity. This is mainly caused due to improper impression techniques and tooth preparation which therefore leads to a decrease in longevity of the fixed dental prosthesis. Impression making is the first part of this process by creating a negative form of the teeth and tissues into which gypsum or other die materials can be processed to create the active analogs. This process is as much an art as it is a science [3]. To fabricate a single crown (SC) or multiunit fixed dental prosthesis (FDP), an accurate cast is required and can be achieved with either digital or conventional impression techniques.

The most common conventional impression materials used for definitive impressions in fixed prosthodontics are polyvinyl siloxane (PVS) and polyether (PE). These materials exhibit excellent dimensional stability and precision and have been successfully used in fixed prosthodontics for many decades. Factors such as variation in temperature, length of time between impression making and pouring, surface wettability of the gypsum product, and disinfection procedures may result in distortion of the impression material which finally affects its accuracy in replicating the details. Also, the application of a die hardener and die spacer, as well as laboratory steps for prosthesis fabrication such as waxing, investing, casting, or pressing process, may introduce dimensional errors and affect the fit of the definitive restoration.

Computer-aided design (CAD) and computer-aided manufacturing (CAM) techniques have been introduced into dentistry to simplify and improve the quality of final

restorations. As a result of which the use of digital impressions for crown fabrication procedures in clinical practice has steadily increased which led to the production of more accurately fit milled restorations and the widespread use of a digital workflow for

Prosthesis fabrication.

Digital impressions in prosthodontics have several advantages compared with conventional techniques such as elimination of laboratory production steps that may cause misfit, lessened transport time between clinic and dental laboratory, and reduced patient discomfort. However, conventional impressions have shown high detail accuracy and are currently routinely and successfully used.[2]So, this study is formulated to evaluate and compare the marginal fit of lithium disilicate copings among conventional and digital techniques.

Materials

12 typhodont teeth (Nissin™)

2. PVS Impression Material (Affinis ® Dcode - Coltene™ Perfect Impression)
3. Tray Adhesives (Coltene Adhesive™)
4. Die stone (Kalrock, Die stone class IV)
5. Inlay wax (Schulder Inlay Wax Blue Schulder Dental Gmbh,ulm,Germany)
6. 48 Lithium Disilicate specimen (Lithium Disilicate Ingot) – IPS – e max™,

IvlocarVivadent, Schaan Liechtenstein.

7. SHOFU™ all ceramic preparation kit.

Equipment

Contact Scanner - Medit I500

Non-Contact Scanner - 3 Shape D 2000

IPS E Max Pressable Furnace - PROGRAMAT EP 5010

Scanning Electron Microscope - JSM6400, JEOL, Tokyo, Japan

Wax Milling Machine - Imesicore 350

Milling Machine - Cerec Mcx Milling Machine

Methodology

In this study, all ceramic tooth preparation was done in central incisor of a typhodont model (Nissin™) of which 48 samples of lithium disilicate crowns were fabricated in which 12 crowns were fabricated using manual wax pattern (1a), 12 crowns were fabricated by using milled wax patterns (1b), 12 crowns were milled after direct scanning of the typhodont model using contact scanner (Medit i 500) (2a) and 12 crowns were milled after indirect canning of the die stone cast of the prepared typhodont model using non-contact scanner (3 Shape D2000) (2b). These 48 lithium di silicate crowns will be placed on a clear acrylic die and placed in the scanning electron microscope to compare the marginal integrity of lithium disilicate crowns among digital and conventional techniques.

Result

The mean marginal gap on the Buccal side for Group 1a was 96.748 ± 12.428, for Group 1b was 63.924 ± 7.074, for Group 2a was 29.023 ± 10.628 and Group 2b was 48.392 ± 13.127. These differences in the mean marginal gap on the Buccal side between the 4 groups were statistically significant at $p<0.001$. This infers that Group 2a showed significantly least mean marginal gap, followed by Group 2b, 1b & highest with Group 1a. The mean marginal gap on the lingual side for Group 1a was 99.903 ± 14.952, for Group 1b was 79.759 ± 14.541, for Group 2a was 40.185 ± 7.529 and for Group 2b was 55.327 ± 6.760. These differences in the mean marginal gap on the lingual side between the 4 groups were statistically significant at $p<0.001$. This infers that Group 2a showed significantly least mean marginal gap, followed by Group 2b, 1b & highest with Group 1a.

Conclusion

Marginal accuracy was least in the case of the conventional group and the highest marginal accuracy was seen in crowns milled by using contact scanners.

Keywords: Marginal integrity, lithium disilicate crowns, CAD-CAM, Medit i 500, 3shape D2000, JSM6400, JEOL, Nissin™

Introduction

Once DeVan quoted that: "Perpetual preservation of what remains is more important than the meticulous replacement of what is missing" it still rings true. The major factor affecting the longevity of the fixed dental prosthesis is marginal integrity. This is mainly caused due to improper impression techniques and tooth preparation which therefore leads to a decrease in longevity of the fixed dental prosthesis. Impression making is the first part of this process by creating a negative form of the teeth and tissues into which gypsum or other die materials can be processed to create the active analogs. This process is as much an art as it is a science [3]. To fabricate a single crown (SC) or multiunit fixed dental prosthesis (FDP), an accurate cast is required and can be achieved with either digital or conventional impression techniques.

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Sample (n = 10)	Marginal integrity (n=12)
GROUP 1 A Conventional wax pattern	MI 1=12
GROUP 1 B CAD/CAM technique for wax pattern fabrication	MI 2=12
GROUP 2 A Contact scanner (Medit i50)	MI 3=12
GROUP 2 B Noncontact scanner (3Shape D2000)	MI 4=12

Table 1

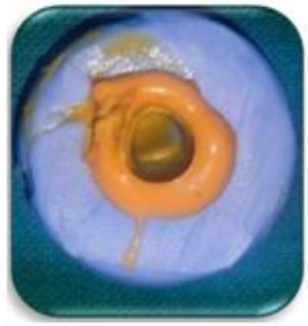


Fig.1: Addition silicone mold

Fig. 2: Acylic Die

Fig. 3: Addition silicone impression of the prepared

Fig. 4: Die stone model of the typhodont jaw

Fig. 5: Manual wax pattern

Fig. 6: Scanned images of typhodont jaw

Fig. 7: Design of wax pattern

Fig. 8: Milling of wax pattern

Fig. 9: Milled wax pattern

Fig. 10: Conventional crowns manufactured

Fig. 11: Sprue attachment

Fig. 12: Investment of the wax pattern

Fig.13: Manufacturing of Pressable lithium disilicate crowns

Fig. 14: Conventionally manufactured crown using milled wax pattern

Fig. 15 : Direct scanning of the prepared typhodont jaw

Fig. 16: Designing of lithium disilicate crown

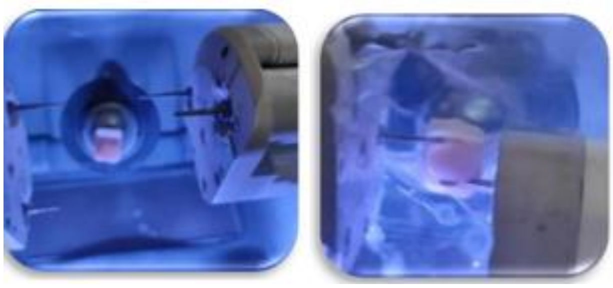


Fig. 17: Milling of lithium disilicate crown

Fig. 18: Lithium disilicate crowns fabricated using direct intraoral scanner

Fig. 19: Indirect scanning of the prepared typhodont jaw

Fig. 20: Designing of lithium disilicate crown

Fig. 21: Milling of lithium disilicate crown

Fig. 22: Lithium disilicate crowns fabricated using direct intraoral scanner.

Fig. 23: Lithium disilicate crowns mounted on acrylic die.

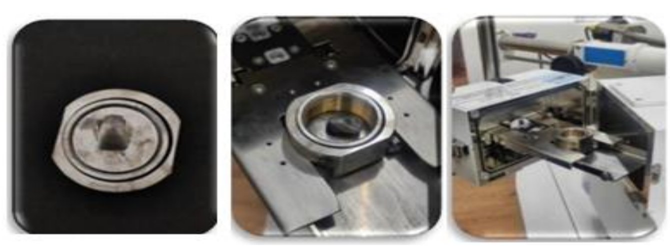


Fig. 24: Silver sputtered sample mounted on a metallic base and placed in the scanning electron microscope.

Result

The mean marginal gap on the Buccal side for Group 1a was 96.748 ± 12.428, for Group 1b was 63.924 ± 7.074, for Group 2a was 29.023 ± 10.628 and Group 2b was 48.392 ± 13.127. These differences in the mean marginal gap on the Buccal side between the 4 groups were statistically significant at $p<0.001$. This infers that Group 2a showed significantly least mean marginal gap, followed by Group 2b, 1b & highest with Group 1a. The mean marginal gap on the lingual side for Group 1a was 99.903 ± 14.952, for Group 1b was 79.759 ± 14.541, for Group 2a was 40.185 ± 7.529 and for Group 2b was 55.327 ± 6.760. These differences in the mean marginal gap on the lingual side between the 4 groups were statistically significant at $p<0.001$. This infers that Group 2a showed significantly least mean marginal gap, followed by Group 2b, 1b & highest with Group 1a.

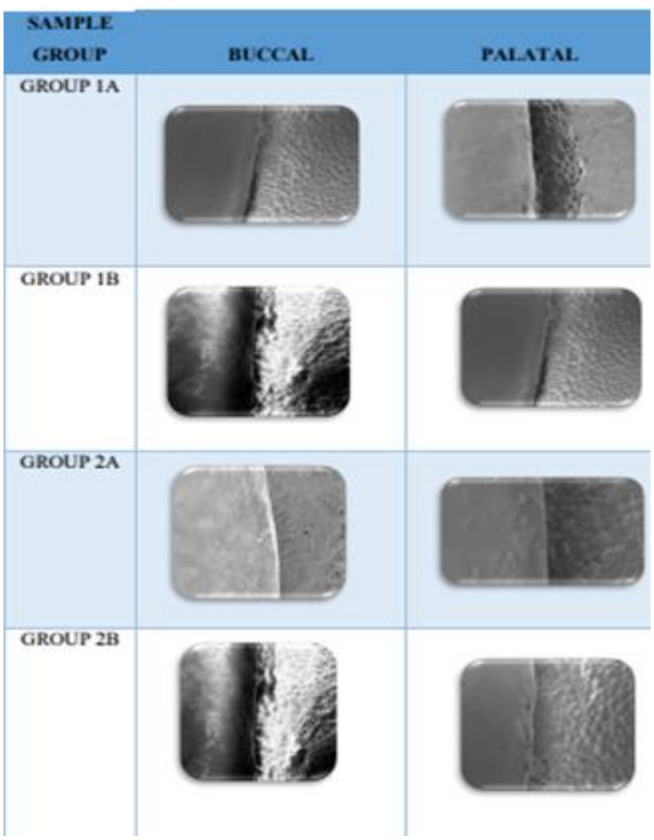
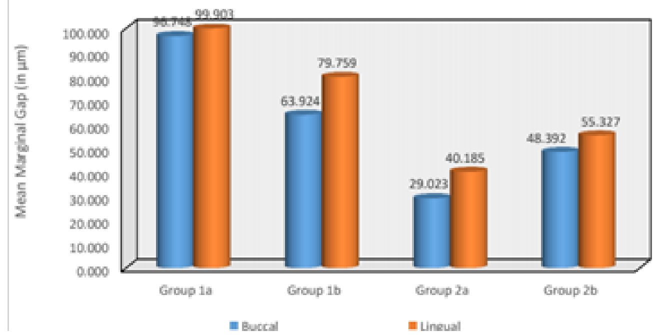


Fig. 25: Scanned Images



Graph 1 : Mean Marginal Gap in (in µ) between buccal & lingual side in each study group .

Discussion

In the present study, the marginal accuracy of lithium di silicate crowns processed by both conventional and digital impression technique were studied. The external marginal gap of these crowns were then analysed in scanning electron microscope .According to L KORKUT, the decreased amount of marginal gap width was important in all ceramic crowns because of the polymerization shrinkage of the resin composite cements . In this study, the acceptable marginal gap was below 100 µm. The mean marginal gap found in lithium di silicate crowns manufactured in {1a} conventional technique was 96.748 µm in the mid buccal region and 99.903 µm in mid palatal ; {1b}using conventional impression technique with milled wax pattern was 63.924 µm in mid buccal region and 79.759 µm in mid palatal region ; {2a} using Medit i500 procured a reading of 29.023 µm in mid buccal region and 40.185 µm in mid palatal region ;{2b} using 3 Shape D 2000 scanner gave a reading of 43.392 µm in mid buccal region and 55.327 µm in mid palatal region. With these results it was evident that the marginal gap was more in the crowns which were fabricated in conventional group and the least marginal gap was seen in the crowns fabricated by scanning the typhodont model using direct contact scanners (Medit i500) which in turn infers that increased marginal accuracy of lithium di silicate crowns were encountered in the group which was scanned using Medit i500.

In similar study by Yeo and others, maxillary central incisors was prepared with shoulder finish line and marginal gap was evaluated without cementing and cross sectioning the IPS Empress II crowns. The mean marginal gap width was 46 µm ± 16 µm in their report. In the current study, the intraoral digital scanning group presented lowest mean misfit value, compared to other groups. This was explained by the fact that there was no need for impression or casting materials to perform intraoral scanning. These material irrespective of their type and quality, they undergo some degree of dimensional changes. When intraoral digital scanning is used for fabrication of structure of single and multiple fixed partial restoration, the impression and cast steps may be eliminated, thus contributing to obtain a precise dental prosthesis.

In an in vivo study by Flugge TV, the precision of direct and indirect digital scanners were evaluated. He concluded that the intraoral scanners was less precise, because of the conditions of the oral cavity, such as the presence of saliva and limited access by the scanner. But this study was conducted in a laboratory environment to eliminate the influence of clinical errors such as varying parameters of tooth preparation including bleeding, saliva, finish line and their influence on convention of digital impression technique.

The results of the present study were almost similar to those of previous study. Brawek et al compared the marginal fit of 2 extraoral CAD/CAM systems , LAVA and CEREC AC/ inlab with the conventional technique to find that all digitally fabricated crowns were within the clinically acceptable range.Syrek et al compared the marginal accuracy of crowns fabricated with LAVA chair side oral scanner and the lost wax technique. The author concluded that optical scanning and milling produced a significantly smaller marginal gap than that produced using traditional technique .

Several laboratory devices , such as light microscope, stereomicroscope , digital microscope and SEM ranging from 25x to 100x magnification ; were used in other studies to observe the marginal fit accuracy of the crowns. Scanning electron microscope was incorporated in the current study; the measurement were made by the digitally captured images. Special software was also employed for this purpose. So, this was considered to be free from observer‘s failure .

Conclusion

At this moment, it can be stated that digitalization have created a revolution in the field of dentistry. Dental restorations fabricated with the digital impression technique presented statistically lesser marginal gaps compared with those obtained with the conventional impression technique. In the results obtained from this study: In in vitro experiments, it can be concluded that contact scanners (Medit i500) projects higher accuracy as compared with non-contact scanners and conventional technique.

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