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A Comparative Evaluation of The Overall Adaptation and Passivity in Copings Obtained By Laser Metal Sintering and Conventional Casting Technique: an in Vitro Study

KEYWORDS: Passivity, Overall adaptability , Laser metal sintering.

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ABSTRACT *OBJECTIVE:In vitro study was done to assess the overall adaptability and pas siv ity of copings fabricated by laser sintering technique and by conventional technique.METHODOLOGY: Thirty extracted maxillary premolars were prepared using torpedo bur taking care to maintain constant taper of the preparation. Samples were divided into conventional casting and laser sintering group. Passivity of copings was evaluated using strain gauge. Overall adaptability was evaluated using light body silicone material. Internal gap was checked by measuring the thickness of silicone material under optical microscope.RESULTS: Strain generated by coping fabricated using conventional and laser casting method were 15.67 μ and 14.67μ respectively. Overall gap was highest on occlusal central region as compared to mesial and distal axial surfaces for both the groups. CONCLUSION: Copings fabricated by both the methods do not have significant difference in their passivity and overall adaptability.*

INTRODUCTION:

The branch of prosthodontics mainly deals with replacing a missing teeth and part of stomatognathic system. Among all the available treatment modalities fixed dental prosthesis (FDP)fabrication is the most common and most acceptable among patients since many decades. Initially precious metals like gold and gold alloys were used to fabricate crowns and bridges. The drawback of gold alloy was that they were esthetically poor due to its colour and they had higher cost. To make them more esthetically acceptable and cost effective various semi-precious and base metal alloys combinations were introduced for making fixed dental prosthesis. Recent advances in material sciences have developed metal free ceramic materials which have excellent esthetics and life like appearance. Most commonly used alloys are Ni-Cr and Co-Cr alloys.

Most commonly used technique for fabrication of crowns and bridges is by lost wax technique which is very technique sensitive. The laser metal sintering system was developed as an alternative to the traditional casting technique to produce more effective and standardized fixed dental prosthesis. Direct laser metal sintering uses high-temperature laser beam to selectively substructure metal powder based on the CAD data with the FDP design. A thin layer of the beamed area becomes burnt and the FDP is completed by laminating these thin layers. The advantages of direct laser metal sintering is that it saves material, time, expenses and the production is simpler compared to existing methods.

One of the most important factors in evaluating the quality of fixed dental prostheses is their internal adaptability and passivity of crown, which determines the success and longevity of the restoration. poor adaptation of crown to the underlying tooth leads to micro leakage at the margins,plaque accumulation ,secondary caries and ultimately leads to periodontal breakdown. Another important factor which should be taken into consideration is equal stress distribution. If overall adaptability of crown is poor, there will not be equal distribution of masticatory load which can lead to concentrated stress generation at one point which can lead to fracture of tooth or prosthesis. The crown should passively seat on the abutments without much of a friction to the tooth surfaces. If crown is not passive it will generate more stresses on the tooth which is detrimental in nature. The aim of the present study was to assess and compare the overall adaptation and passivity of copings, obtained by direct laser metal sintering and conventional casting technique.

METHODOLOGY:

Total 30 extracted teeth were collected for the study between December 2013 to march 2015 from the patients visited department of oral and maxilla-facial surgery, A.B.Shetty Memorial Institute of Dental Sciences,Mangaluru. The teeth were divided into 2 groups of 15 each.

Preparation of teeth:

Teeth were disinfected with 5.2% sodium hypochlorite solution and were mounted using type III dental stone. Teeth were prepared using torpedo diamond bur with chamfer finish line. Occlusal reduction was kept minimum 2mm and axial reduction of minimum 1.5 mm was maintained. The taper of preparation was maintained within acceptable range and preparation was finished and polished. All the teeth were prepared by one clinician to eliminate bias.

Preparation of copings:

15 teeth received crowns made by conventional casting technique and 15 teeth received copings made from laser sintering method(EOSINT M-270). Copings were fabricated using Co-Cr alloy in both the conventional and laser sintering group. After casting copings were finished and polished.All the procedures to fabricate copings were per-

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formed in a commercial laboratory with great care to avoid any casting defects and eliminate errors.

Method of measuring passivity of copings:
Strain gauges (Tokyo Sokki kenkyujo co., ltd.) of 2x2 mm dimensions were used to measure the passivity of the copings fabricated by two different manufacturing methods. Strain gauges were stick to the root portion of the prepared teeth and it is attached to the digital strain indicator which showed the amount of strain generated when coping is positioned on prepared tooth under constant load of 10 N. Digital strain indicator showed measurement in microstrain unit(Figure 1).

Figure 1: strain gauge applied on tooth

Method of recording overall adaptability of copings:
Elastomeric impression material was used to evaluate the internal gap between tooth and coping. Internal surface of coping was luted with elastomeric impression material and copings were positioned on teeth using firm finger pressure to make sure they seat accurately till the margin of tooth. Excess material was wiped off using cotton before it sets to avoid tearing of thin film of silicone material. Once material is set the coping is sectioned labio-lingually along with the tooth using metal cutting disk. Sectioned specimen shows thin film of silicone material present between metal coping and tooth surface. Thickness of this film is measured under light microscope(MOTIC) to evaluate overall adaptability.

Three points were selected one on mesial, distal and centre occlusal side for measuring thickness of silicone material present between tooth surface and coping.

STATISTICAL ANALYSIS: The data obtained was analysed using SPSS software. The passivity and overall adaptability (internal gap) of both the groups were evaluated using student t –test to determine the effect of the two different manufacturing methods of crown fabrication.

P< 0.05 was considered as statistically significant.

RESULTS:
TABLE 1: Mean microstrain (passivity) values for each group

	GROUP	N	Mean	SD	Mean difference CI (95%)	T	df	p-value
Microstrain	Conventional	15	15.67	7.68	1.00(-4.78, 6.78)	0.35	28	0.72(NS)
	Laser	15	14.67	7.78				

p<0.05 statistically significant

TABLE 2: Mean internal gap(overall adaptability) of copings on occlusal, mesial and distal surfaces

	GROUP	N	Mean	SD	Mean difference CI (95%)	T	Df	p-value
Mesial	Conventional	15	128.87	29.78	6.93 (-13.58, 27.45)	0.69	28	0.49(NS)
	Laser	15	121.93	24.85				
Centre	Conventional	15	244.73	44.59	1.80(-30.14, 33.74)	0.11	28	0.90(NS)
	Laser	15	242.93	40.74				
Distal	Conventional	15	123.07	30.14	-3.80(-25.15, 17.55)	-0.36	28	0.71(NS)
	Laser	15	126.87	26.84				

P<0.05 statistically significant

Table 1 shows the copings fabricated with laser metal sintering method and conventional casting method showed almost similar values of strain generation on teeth surface. Conventional group has mean value of 15.67 (±7.68) μ strain generated on teeth surface and laser sintered copings have mean value of 14.67 (±7.78) μ strain. The p value= 0.72 which is non-significant.

Table 2 shows the overall adaptability of copings fabricated with laser metal sintering method and conventional casting method on 3 different points: mesial, distal and occlusal surfaces. On mesial side conventional group shows mean internal gap value of 128.87(±29.78)μm whereas laser group shows mean value of 121.93(±24.85)μm.(p =0.49) is non-significant. ($t_{(28)}$= 0.69,p = 0.49) On distal surface conventional group shows mean internal gap value of 123.07(±30.14)μm ,whereas laser group shows mean value of 126.87(±26.84)μm. (p =0.71) is non-significant.($t_{(28)}$= 0.11, p = 0.71) On occlusal surface in the centre of the tooth conventional group shows mean gap of 244.73(±44.59)μm and laser group shows mean value of 242.93(±40.74)μm. (p= 0.90) is non-significant.

DISCUSSION:
The passivity and internal overall adaptability of crown are the most important factors in determining long term success of any prosthetic treatment. Various newer methods of crown fabrication are available and wide range of different materials have been tried to fabricate dental prosthesis. It is very important to evaluate the efficiency and accuracy of these newer technologies in fabricating dental castings with improved properties than the conventional technique. One such technique that has become popular is direct laser metal sintering technology.

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The main advantage of this process is it can process 90-120 copings in one lot, which significantly increases the production and saves lot of valuable clinical and laboratory time, however the cost of fabrication is relatively higher than conventional technique. This process eliminates the chances of porosity in the casting as the metal particles are very minute (3-14 µm) and densely fused.

In the present study passivity was measured using strain gauge and results showed negligible difference in generated strain between two experimental groups.

Various authors have done studies and they have given their own recommendations for clinically acceptable internal and marginal fit values. Mclean et al did study to evaluate marginal gap and according to that study 100 µm gap can be considered as clinically acceptable.[20] According to the study done by Kashani et al marginal gap more than 100µm is clinically unacceptable. This study supported the results of the previous study.[21] But Blackman did study and gave contradictory results and he concluded that marginal gap more than 50 µm is not acceptable.[22] Bindl and Mörmann conducted study to measure marginal and internal gap and they found wide range of values for marginal and internal studies also shows that it can range between 200-300 µ.[23] In the present study silicone replica method was used to measure internal gap as it is easy and less destructive It was found that internal gap measured using silicon material under optical microscope in both the groups were almost similar and difference was negligible. . These results are consistent with the study done by Ortorp et al[9] , but opposite to the results of the study done by Ucar et al[2].This difference is mainly because of the difference in the specimens used in both the studies. Ortorp et al used cylindrical models and other studies with opposite results have used anatomical tooth forms which are more complex than cylindrical forms.. One more finding observed by investigator regarding occlusal anatomy and its effect on internal gap. If occlusal preparation has steep cuspal inclines, the copings fabricated on such tooth will have more internal gap in occlusal region and vice versa.

CONCLUSION:

Considering results of the present study and from the literature review, it can be concluded that methods used for coping fabrication have minimal influence on its properties like overall adaptation and passivity. The difference if present, is very minimal and within the acceptable range. So the newer technique of crown fabrication by laser sintering can be accepted as better alternative to the conventional one. Further research needs to be conducted in the area of mechanical properties, surface roughness and biocompatibility of crowns fabricated by laser metal sintering technique.

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