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Research Article

A STUDY TO COMPARE THE EFFECTIVENESS OF SURFACE ROUGHNESS AND AUXILIARY TOOTH PREPARATION ON THE RESISTANCE FORM OF COMPLETE METAL CROWNS- ORIGINAL STUDY

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ABSTRACT

This in vitro study assessed the influence of effect of surface roughness and auxiliary tooth preparation on the resistance form of complete metal crowns. Aluminium oxide particles of grit 50µ and 110µ were used to treat the intaglio surface and auxiliary features such as mesio- occluso- distal (MOD) slot and reduced occlusal convergence (ROC) were investigated.

The frequently encountered problem in clinical practice is dislodgement of cast restorations. This displacement is mainly because the tooth preparation features do not oppose the forces led against the restorations. Therefore, the design of the tooth preparation is an important consideration in fixed dental prosthesis.

Materials and Methods: 45 extracted maxillary premolar teeth were mounted on acrylic blocks. They were prepared to a standardised dimension of 3mm and taper of 15-20 degree.15 teeth had MOD slot and 15 teeth had ROC additional auxiliary feature. Cobalt chromium alloy metal crowns were casted. These samples were then segregated and were treated with aluminium oxide particles of 50 µ and 110 µ. The crowns were then cemented with glass ionomer cement and tested under universal testing machine at angle of 45 degrees to evaluate the resistance form. The force required to dislodge the crown was noted as resistance value.

Results: There was significant difference in the resistance values when cobalt chromium metal crowns were treated with aluminium oxide particles and were incorporated with auxiliary feature. ($p<0.001$).

Interpretation and Conclusion: Aluminium oxide particles and modified auxiliary features have an influence on the resistance form of complete metal crowns. Therefore, in cases with compromised crown height and taper ROC auxiliary feature should be incorporated and treated on the intaglio surface with 110µ aluminium oxide particles.

INTRODUCTION

The field of dentistry has revolutionized the missing teeth replacement by implant supported prosthesis, but fixed dental prosthesis is still the most incessant option for restoring them. It not only provides satisfaction with the esthetics, functional demands but also serves as a reasonable treatment choice.

Tooth preparations based on mechanical, biological and esthetic principles predict future clinical outcome of fixed prosthodontic treatment, hence they must be done with meticulous attention and skill.

The frequently encountered problem in clinical practice is dislodgement of cast restorations. This displacement is mainly because the tooth preparation features do not oppose the forces led against the restorations.

Therefore, the design of the tooth preparation is an important consideration in fixed dental prosthesis.

Factors like retention and resistance form are very important in tooth preparation and subsequent successful restorations.

Resistance form is defined as the features of a tooth preparation that enhance stability of a restoration and resist dislodgement along an axis other than the path of placement.[1]

The three factors which determine acceptable resistance to dislodgement are: magnitude and direction of the dislodging force, geometry of the tooth preparation, and physical

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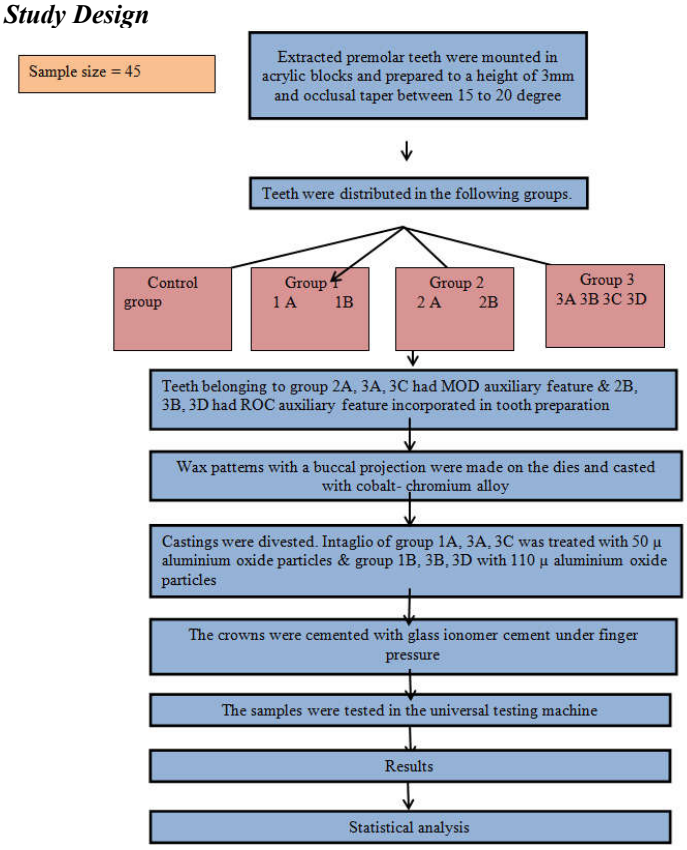
properties of the luting agent. Out of these three, the dentist may not be able to control the magnitude and direction of the dislodging force adequately as it is an immanent patient factor. Tooth preparation geometry encompasses total occlusal convergence (TOC) and height and width of the preparation are closely interrelated and must be taken in to consideration while determining adequate resistance form.

Some methods recommended to increase the resistance form are incorporation of grooves, boxes, total occlusal convergence, incorporation of inclined planes on occlusal surfaces, re-preparation of axial walls at reduced total occlusal convergence.

Studies have also shown that the treatment on the inner surface of the copings increase the retention of crowns to the tooth.[2] Even though there are studies reported in the dental literature on retention, the factors involved in the improvement of resistance form are not adequately investigated.

Keeping in mind the principles of tooth preparation as mentioned in the dental literature an attempt is made to compare the effectiveness of surface roughness and auxiliary tooth preparation on the resistance form of complete metal crowns.

Study Design



Experimental Section

A sample of 45 intact extracted maxillary teeth were collected and mounted on a heat cure acrylic resin block below the cemento-enamel junction. Each tooth was uniformly reduced to dimension 3 cm in height.In order to assure that all the prepared teeth have a uniform 15 to 22 degree angulation a customised heat cure acrylic jig was fabricated. High speed air rotor was then attached to the jig which was mounted on a surveyor with preadjusted tilt of 15 degree and all the teeth were prepared.

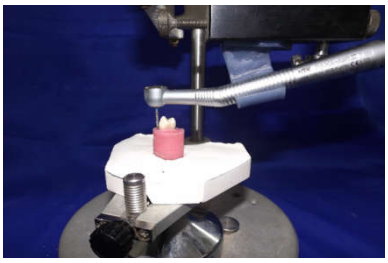


Figure 1 Tooth mounted on surveyor with jig and prepared with air rotor

Figure 2 Customized acrylic jig

After the teeth were prepared they were categorised according to the groups. Two types of auxiliary features i.e. reduced occlusal convergence (ROC) and mesio– occluso -distal (MOD) slot preparation were incorporated in the groups 2A, 2B, 3A, 3B, 3C, 3D respectively.

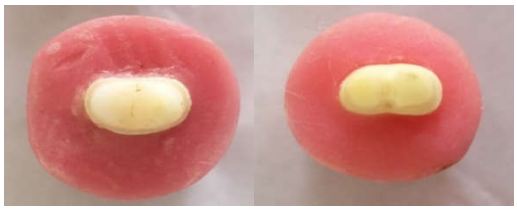


Figure 3 Auxiliary tooth preparation designs

Figure 3 All the prepared teeth arranged in groups

The impressions were made and poured in dental stone and dies were made. Wax patterns were made of uniform 0.5 mm thickness with 1 mm projection on the buccal cusp.

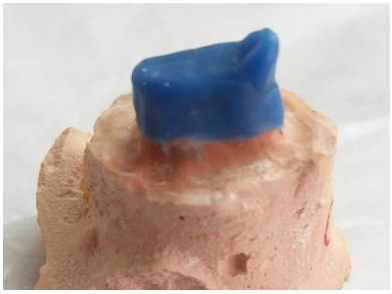


Figure 4 Wax pattern fabricated with projection on buccal aspect

The wax patterns were then invested and casted in cobalt chromium alloys.The crowns belonging to each group were treated with various surface treatments described in the study deign. In order to remove the investment from the intaglio surface of control group and group 1, a straight fissure bur was used and the crowns were kept in ultrasonic cleaner for 180 seconds.

The surface treatment was done with aluminium oxide particles of grid 50µ for groups 1A, 3A, 3C and 110 µ for groups 1B, 3B, 3D. Each crown was held at a distance of 10mm for 10 secs. The intaglio surface was evaluated for any investment residue if found, the treatment was repeated.

Figure 5 Sandblasting unit and Ultrasonic cleaner

The crowns belonging to each group were cemented with glass ionomer cement type 1 as per manufacturer's instruction under finger pressure to the respective prepared teeth.

In order to test the resistance form, the crowns were placed at 45 degree to the long axis. The teeth mounted on the acrylic blocks were placed in a customised platform. The assembly was tested under the universal testing machine with the crosshead speed at the rate of 0.5 mm/minute.

Figure 6 Tooth mounted on customized platform testing under universal testing machine

The force MPa at which the crowns were dislodged was recorded as resistance values The readings at which the crowns were dislodged were noted down.

RESULTS

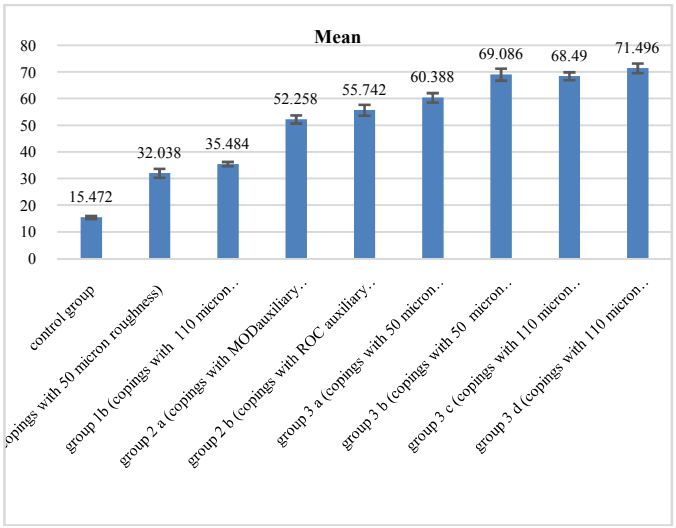
Table

	N	Mean	S.D	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Control Group	5	15.472000	.5366284	14.805688	16.138312
Group 1 a	5	32.038000	1.6553308	29.982635	34.093365
Group 1b	5	35.484000	.8194693	34.466494	36.501506
Group 2 a	5	52.258000	1.5156748	50.376041	54.139959
Group 2 b	5	55.742000	2.0294507	53.222104	58.261896
Group 3 a	5	60.388000	1.7469173	58.218916	62.557084
Group 3 b	5	69.086000	2.2374159	66.307881	71.864119
Group 3 c	5	68.490000	1.4786818	66.653974	70.326026
Group 3 d	5	71.496000	1.8022430	69.258220	73.733780
Total	45	51.161556	18.6062278	45.571626	56.751485
F			721.380		
P value			<0.001*		

*p<0.05 statistically significant,
p>0.005 statistically nonsignificant, NS

Comparison of mean resistance values between the study groups

This table illustrates a comparison of mean resistance values between the groups. ANOVA test was used to statistically examine the values. There is a significant difference in the 9 groups which are depicted in table 2. Mean and standard deviation value of 3D group is highest i.e. 71.496000 and 1.8022430 and lowest of control group i.e. 15.472000 and .5366284.



Graph

This graph depicts the comparison mean resistance of 9 groups. It is seen that Group 3d is the highest roughness with 71.496 mean values and least is in control Group. In Group 1a and 1b, 1 b is higher mean value with 35.484 mean. In Group 2a and 2b, 2b has higher mean value with 55.742 mean values. In Group 3, Group 3a is the least with 60.388 as the mean value. One way ANOVA test shows that there is significant difference in the 9 groups with a p value of <0.001. Post Hoc Tukey test shows the subgroup analysis is significant in all possible combinations except groups 3B-3C, 3C-3D AND 3B-3D which

are not significantly different. They are similar which we can see in the graph also all are in the same range.

DISCUSSION

In the present study, cobalt chromium crowns were fabricated and subjected to 50µ and 110µ aluminium oxide particles and luted with glass ionomer cement. The resistance form was evaluated and was greater when large grit particles were used.
A similar study was conducted by Connor *et al* in which they subjected cast gold crowns to various surface treatments like pickling, micro blasting with 50µ aluminium oxide and 50 µ glass beads particles. The crowns were luted with zinc phosphate cement and evaluated the retention form. They achieved best retention when subjected to 50µ aluminium oxide particles.[2]

In a study conducted by Yasa *et al*, the endodontically treated teeth were prepared with two different types of retentive slots and newer agents were used to analyse the fracture resistance. Retentive slots significantly increased the performance.[3]

Huang *et al* investigated resistance values in 6 groups comprising of 10 either of of maxillary and mandibular molars. The parameters were heights of 4 mm, 3mm and 2 mm and presence or absence of grooves. They concluded that height of 4 mm and 3 mm have enough resistance with or without presence of grooves.[4]

In the present study height of the extracted premolars that was kept at 3mm and the values that were obtained were analogous.
In a study conducted by Pott *et al*, retention and resistance form was tested. Five preparation designs such as three-quarter partial veneer crown without axial grooves, three-quarter partial veneer crown with axial grooves, seven-eighths partial veneer crown without axial grooves, seven-eighths partial veneer crown with axial grooves, and complete veneer crown without grooves were made and castings were fabricated with nickel chromium alloy. They stated that resistance is increased by any preparation feature which opposes dislodgement of the restoration by nonaxial external forces. The maximum resistance value for full veneer crown without groves was 21.54 Mpa.[5]

In difference, the control group in the present study has higher resistance value. However, the tooth prepared in the present study was 1 mm smaller in height and had more taper.

Roudsari *et al* observed that when teeth are prepared with exceeding taper and are short 1.5 mm occlusal convergence should be given which significantly increases the resistance values. They also investigated that grooves aid in increasing the resistance values.[6]
This is similar to the present study where the ROC auxiliary feature incorporated teeth have apical 1.5 mm prepared to improve the resistance values.

CONCLUSION

Within the limitations of the study the following conclusions were drawn:

1. After the assessment of the study, surface roughness of 110 µ and reduced occlusal convergence auxiliary feature had the maximum influence on the resistance form of complete metal crowns.
2. The influence of surface roughness increased the resistance values to a great extent. 110µ aluminium oxide particles had higher influence than 50µ particles.
3. It was noted that reduced occlusal convergence offered greater resistance than mesio- occluso- distal auxiliary feature.
4. The maximum force involved in the dislodgement of crowns after cementation was when they were treated with 110 µ aluminium oxide particles and incorporated reduced occlusal convergence auxiliary feature was 71.496 Mpa.

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