Original Article

An In Vitro Comparative Assessment Of The Effectiveness Of Occlusal Convergence Reduction, Modification Of The Occlusal Surface, And Added Auxiliary Features On Full Veneer Metal Crown Resistance Placed On A Molar Tooth Having Inadequate Resistance Form

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Abstract

Introduction: Owing to the inadequate resistance forms, fixed partial dentures and single crowns get dislodged. Hence, it is vital to assess tooth preparation features that can help in the prevention of these failures due to inadequate resistance form.
Aim: The present study was conducted to assess the effectiveness of occlusal convergence reduction, modification of the occlusal surface, and added auxiliary features on full veneer metal crown resistance placed on a molar tooth having inadequate resistance form.

Materials and Methods: In the present study, a tooth preparation in the ivorine molar of the mandibular arch was done with inadequate resistance form features including total occlusal convergence (TOC) of 20 and an axial wall height of 2.5mm. This was followed by the addition of seven auxiliary features one after the other including reduced TOC by 8° in cervical aspect, occlusal inclined planes, mesiodistal boxes, buccolingual grooves, buccolingual and mesiodistal grooves, mesiodistal grooves, and mesiodistal grooves added to 8° reduced TOC in the cervical aspect. For each group, 10 dies were prepared with their respective crowns. On the INSTRON testing, resistance testing of all the samples was done.
machine.
Results: Statistically significant greatest resistance was seen by modifying the over tapered die preparation by decreasing the TOC to 8° in the cervical 1.5mm of the axial wall with the subsequent addition of mesiodistal groove to the decreased cervical TOC leading to the highest resistance to the dislodgement.
Conclusion: The present study concludes that for a crown preparation that is over tapered, decreasing the total occlusal convergence in the cervical area to 8° and further adding the proximal groves results in maximum resistance form in the preparation.

Keywords: Auxiliary features, molar tooth, over tapering, resistance form, taper

INTRODUCTION

In general dentistry, most of the work done during practice relies on crown preparation, fabrication, and fixed partial dentures. The success of these crown preparation, fabrication, and fixed partial dentures largely depends on prolonged resistance and retention of these preparations. The aesthetic and functional components of the dentition in subjects are largely governed by premature restoration loosening.[1]

Concerning this feature, one of the most vital requirements is the resistance from which is analysed by mathematical, clinical, as well as theoretical methods. Previous literature data suggest that failure rates of the castings because of Decementation were found to be more than 95% which was attributed mainly to the lack of resistance form which is a vital feature for casting. The most affected teeth for this failure are molars with nearly 63% of the reported cases were seen in molars.[2]

The significance of the resistance form as a vital element for the designs of crown preparation design can be assessed by various facts and figures. These results from previously documented literature data agree with the basic principle in prosthodontics which states that resistance form is an integral and vital element in the crown preparation design. Previous data by some authors suggest a taper of 6^{o} in the crown preparation design, however, other authors recommend a total convergence angle of 20°–25°.[3]

In teeth with extreme taper, additional auxiliary features are given including boxes and grooves in the prepared teeth which help achieve the desired resistance forms.[3] Hence, the present study was conducted to assess the effectiveness of occlusal convergence reduction, modification of the occlusal surface, and added auxiliary features on full veneer metal crown resistance placed on a molar tooth having inadequate resistance form.

MATERIALS AND METHODS

The present study was conducted after obtaining clearance from the concerned Ethical committee. In the study, an ivorine mandibular first molar was mounted in the acrylic resin that was auto polymerizing. To achieve the adequate resistance form, the required features were a total of 20^{o} occlusal convergence, 1mm wide shoulder finish line, 10 mm external faciolingual dimension, 8mm internal faciolingual dimension, and 2.5mm occluso-cervical dimension. An Air-rotor handpiece was used for the tooth preparation. A flat surface was prepared occlusally, whereas, axially, 2.5mm walls were prepared. To the bur and handpiece, the same angulation was given by adjusting the pointer at 10^{o} on the protractor which leads to a taper of 10^{o} in all axial surfaces and total occlusal convergence of 20^{o}.

OC/FL (occluso-cervical/faciolingual) ratio was achieved by calculating it from external tooth dimensions. Similarly, on assessing this ratio using faciolingual dimensions it was seen to be 0.31. Both these assessed ratios did not fulfil the minimal value suggested for the molars. To assess the cervical faciolingual distance at the centre of the mesiodistal dimension of the tooth Vernier calliper was used. The distance was assessed to assess the potential resistance from ion the die. Previous literature data suggest that the boundary circle radius in which no resistance form is offered by preparation design.

A special tray made up of auto polymerizing acrylic resin was made on the tooth preparation with 5-6mm space as required for the impression material of polyvinylsiloxane. Using one-step light body/putty, the impression was made which was used to duplicate the tooth preparation in 10 wax models. Standard protocol was used to polish, finish, and cast. To standardize the die position concerning the testing pin of the jig, the metal die was mounted in an acrylic resin block with a mould that was fabricated especially. These 10 blocks were numbered from 0 to 9. On the cuspal incline of the pattern, 2mm grooves were made for the tip of the testing pin in the universal testing machine.

For crown cementation to the metal dies, glass ionomer cement was used. The crown was subjected to a load of 5 kg for 2 minutes with a spring load metal press machine to maintain constant seating force. Group I specimens were contributed by them serving as the control group. For all the groups, the same procedures were followed following the addition of the specific auxiliary feature in the die as mentioned. In group II, mesiodistal grooves were added mesiodistally and faciolingual depth 1mm, Group III added buccolingual and mesiodistal grooves to Group I, and for Group IV, buccolingual grooves were added to Group I by blocking mesiodistal groove with wax. For Group V, mesiodistal grooves were added, for Group VI, occlusal planes were inclined at 30^{o}, for Group

VII, TOC was reduced to 8^0 in Group I, mesiodistal grooves, and Group VIII added a mesiodistal groove to group VII as shown in table 1.

To test the resistance, of all the samples of all the groups automated universal testing machine was used. The crowns following cementation were subjected to force which was increased gradually at 45^o to the cuspal inclines by the machine. The casting dislodgement was an indication of casting failure and showed the maximum force value of that specimen. The collected data from testing were subjected to statistical evaluation and the results were formulated.

RESULTS

The present study was conducted to assess the effectiveness of occlusal convergence reduction, modification of the occlusal surface, and added auxiliary features on full veneer metal crown resistance placed on a molar tooth having inadequate resistance form. The study results showed that the resistance force of each group was assessed. It was seen that for Group I, the mean resistance force of dislodgement was 115.61kg/s^2. The lowest resistance force was reported in Group I. For Group VIII, the resistance force recorded was highest and was 418.44 kg/s^2.

ANOVA or analysis of variance was used to assess the difference between the 8 study groups having 10 samples each. The F value calculated was 58.25 which was significantly higher than the critical value for F which was 2.9 at the considered significance level. These results indicate that some features of the tooth preparation show higher resistance to the forces of dislodgement compared to the other features. For individual assessment of study groups to Group I, no statistically significant difference was seen between the mean values of Group II, III, IV, V, and VI the Group I.

For Group VII and VIII, the respectively calculated f-values were 9.645 and 15.02 which were significantly higher compared to the critical f-value which was 2.554 when assessed for the considered level of significance on its comparison to Group I. These results shows that statistically significant difference was seen in the mean values of resistance for Group I in comparison to Group VII and Group VIII. Also, the study results show that a statistically significant difference was seen between mean values of resistance force by the addition of mesiodistal grooves in group VIII compared to the other two groups.

DISCUSSION

The present study was conducted to assess the effectiveness of occlusal convergence reduction, modification of the occlusal surface, and added auxiliary features on full veneer metal crown resistance placed on a molar tooth having inadequate resistance form. The study results showed that the resistance force of each group was assessed. It was seen that for Group I, the mean resistance force of dislodgement was 115.61kg/s^2. The lowest resistance force was reported in Group I. For Group VIII, the resistance force recorded was highest and was 418.44 kg/s^2. These values were comparable to the results of Tomar SS et al[4] in 2015 and Blair FM et al[5] in 2002 where authors reported comparable results on adding auxiliary features to the tooth preparation.

Analysis of variance was used to assess the difference between the 8 study groups having 10 samples each. The F value calculated was 58.25 which was significantly higher than the critical value for F which was 2.9 at the considered significance level. These results indicate that some features of the tooth preparation show higher resistance to the forces of dislodgement compared to the other features. For individual assessment of study groups to Group I, no statistically significant difference was seen between the mean values of Group II, III, IV, V, and VI the Group I. These results were consistent with the results of Farshad B et al[6] in 2013 and Roudsari RV et al[7] in 2011 where authors reported similar results as in the present study.

Concerning Group VII and VIII, the respectively calculated f-values were 9.645 and 15.02 which were significantly higher compared to the critical f-value which was 2.554 when assessed for the considered level of significance on its comparison to Group I. These results shows that statistically significant difference was seen in the mean values of resistance for Group I in comparison to Group VII and Group VIII. Also, the study results show that a statistically significant difference was seen between mean values of resistance force by the addition of mesiodistal grooves in group VIII compared to the other two groups. These results agreed with the results of Chandra Shekhar S et al[8] in 2010 and Tiu J et al[9] in 2015 where authors also depicted that the addition of mesiodistal grooves in tooth preparation results in better resistance form in the tooth preparation,

CONCLUSION

Within its limitations, the present study concludes that for a crown preparation that is over tapered, decreasing the total occlusal convergence in the cervical area to 8° and further adding the proximal groves results in maximum resistance form in the preparation. However, the present study had a few limitations including smaller sample size, geographical area biases, in-vitro nature, and single-institution nature. Hence, more studies in vivo are warranted to reach a definitive conclusion.

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TABLES

S. No	Groups	Added features	F value
1.	I	Controls	2.554
2.	II	mesiodistal grooves of depth 1mm	58.25
3.	III	buccolingual and mesiodistal grooves to Group I	2.9
4.	IV	buccolingual grooves were added to Group I by blocking mesiodistal groove with wax	-
5.	V	mesiodistal grooves were added	-
6.	VI	occlusal planes were inclined at 30^{o}	-
7.	VII	TOC was reduced to 8^{0} in Group I, mesiodistal grooves	9.645
8.	VIII	TOC was added to 8^{0} in Group I, mesiodistal grooves	15.02

Table 1: Group distribution in the present study