Impact of Auxiliary Features on Retention of Short Dental Crowns: An In-Vitro Analysis of Box and Groove Preparations

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Background: Several auxiliary features have been proposed to achieve sustainable retention for short-prepared dental crowns; however, achieving retention is challenging. This study aimed to assess the impact of increased total occlusal convergence and auxiliary preparation factors like box and groove on the retention form of short tooth preparations.

Material/Methods: Eighty resin machine-milled dies with a height of 3 mm and a deep chamfer margin of 1 mm were prepared to mimic the short-prepared molar. Initially, 2 teeth were prepared following the guidelines, and the total occlusal convergence was kept at 10° and 20°, respectively. Auxiliary features such as the proximal box and buccal groove were prepared on separate 20° dies. Eighty dies were prepared with 10 samples each for 10°, 20°, 20° with proximal box and 20° with buccal groove for zirconia (n=40) and metal crowns (n=40). Cementation was done with glass ionomer luting cement, and a pull-off test was conducted. Data were analyzed using one-way analysis of variance and post hoc fisher least significant difference test (P<0.05).

Results: The highest mean was observed in the proximal box group with the metal crown (14.59), and the lowest in the group with 20° zirconia crowns (9.12). Within groups, the highest retentive values were found for the 20° taper with proximal box preparation; the lowest was for the 20° taper group.

Conclusions: Within the study limitations, it could be concluded that incorporating a proximal box or buccal groove in short tooth preparations with an increased total occlusal convergence improved retentive values.

Keywords: Dental Prosthesis Retention • Tooth Crown

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Background

Dental crown retention, a fundamental aspect of prosthodontics, depends on tooth preparation, cement choice, and crown-tooth interface. Tooth preparation must include mechanical retention, and crown design must favor convergence angles and occlusal clearance for optimal dental results. Retention of the crown is significant for long-term effectiveness and functional rehabilitation in restorative dentistry. Retention is described as the prevention of dislodgment of the cast restoration along with its path of insertion, while resistance is the prevention of dislodgment by lateral forces [1,2].

Goodacre et al suggested the attributes that should be considered in the preparation of a tooth: a range of 10° to 20° of total occlusal convergence (TOC), a minimum occluso-cervical dimension of 4 mm for molars and 3 mm for all other teeth, and a height to base ratio of 0.4 or higher [3]. Empirical evidence indicates that a range of factors, such as the taper and form, dislodging forces, vertical forces, and type of cement used, can influence the retention of a dental crown. Modification techniques have been suggested to improve the retention of a dental crown when it is cemented to a tooth that has undergone standard preparation and when the tooth’s dimensions have been compromised.

TOC, as the literature suggests, is one of the most critical factors in preparing a tooth to receive a crown [4]. The amount of taper that can be attained through experimental and therapeutic means is not within the range of 2° to 5° but instead falls within the scope of 12° to 22° [2,4,5]. However, Jørgensen [6] and Kaufman et al [7] demonstrated an inverse relationship between increased TOC and retention. The optimum TOC in complete veneer preparations is influenced by several factors, including accessibility, morphology, proximal contacts between teeth, and operator expertise [8-10].

The literature suggests that 68.8% of cast restoration failure depends upon mechanical factors (crown preparation, cementation, and materials), while 28.8% of failure depends on biological factors (soft tissue support) [11]. Additionally, the primary causes of restoration failures were insufficient clinical crown length and the extent of tooth damage before treatment and debonding [12,13]. However, ongoing debate continues regarding the optimal material, most suitable cement, and most efficacious approach for enhancing retention in cases involving short clinical abutments [14].

Occluso-cervical height also plays a critical role in the retention of a crown. This can be compromised in conditions of morphological tooth wear, such as attrition, abrasion, and erosion, and in cases with extensive caries, fractures, occlusal discrepancy, developmental anomalies, and abfractions. Dentists can encounter challenges in achieving optimal retention and resistance forms during the preparation of these teeth. If the restoration is lost, it can impose various esthetic and functional challenges. In a significant majority of clinical cases, it was observed that short clinical abutments resulted in the dislodgement of crowns in around two-thirds of instances [15]. Ideally, 4 mm is the minimal preparation height recommended for posterior preparations, and in situations of short clinical crowns, achieving this is very difficult and adversely affects retention, which is of great concern [16-19]. In such situations, the alternatives are either crown lengthening surgery or the incorporation of various retentive features, such as grooves, boxes, and pins, in the preparation. Studies have evaluated the effect of these auxiliary features on the retention of the prosthesis [20-23].

Full coverage restorations are a treatment of choice whenever maximum retention and resistance forms are desired. Also, the addition of grooves and boxes has been advocated if heavy forces are anticipated in posterior teeth [24].

Published literature has shown the improvement of retention by creating cement locks and a groove, and further modifications with multiple grooves [25-27]. There exist numerous scholarly, and contentious, papers about the management of castings on clinical crowns of reduced height by the integration of supplementary retentive elements [18,22,27-30]. Grooves and boxes increase the entire restoration’s surface area, providing more space for luting cement [28]. Rajkumar et al [22] observed an insignificant increase in retention with the addition of a groove. However, using grooves to enhance retention was encouraged, as the retention was increased by 100% when the cast crown was extended into the groove rather than blocked off [11]. Compared with proximal boxes, proximal grooves yielded a notably increased retention, and including proximal grooves in short preparations resulted in retention comparable to that of a conventional preparation, with sufficient crown height [21]. The placement of grooves and boxes in compromised preparations was not effective when they possessed the same 20° TOC. The potential for reducing total occlusal convergence at the cervical level is also demonstrated to be promising [23] but has limited use. However, Tjan [31] showed that the presence of grooves can also affect the seating of the casting, making it more difficult, and difficulty increases with the increase in the number of grooves.

While there are multiple perspectives on the matter, the precise advantages of such supplementary characteristics remain ambiguous. The objective of the present investigation was to assess the impact of auxiliary preparation factors like box and groove preparation on the retention form of short-prepared teeth. The null hypothesis posited that including a buccal groove or proximal box along with increased total...
occlusal convergence would increase the retention form of a complete zirconia and metal crowns on the molar tooth with short preparations.

**Material and Methods**

This exploratory in vitro research was conducted at the College of Dentistry, Jazan University and was approved by the college ethics review committee (reference number – CODIU-2221I, dated November 10, 2022). This experimental study was conducted to evaluate the effect of the total occlusal convergence and auxiliary features on the retention of complete coverage definitive crowns.

A power analysis for one-way analysis of variance (ANOVA) indicated that the minimum sample size to yield a statistical power of at least 80% with an alpha of 5% and a medium effect size (d=0.45) was 80. For estimation of the sample size, G* Power version 3.1.9.7 (2020) software (Heinrich Heine University Düsseldorf, Düsseldorf, Germany) was used.

**Fabrication of Test Samples**

Two identical typhodont teeth (Practicon, Greenville, NC, USA) # 36 (mandibular left first molar) were prepared to simulate short crown preparations following general preparation guidelines, with specifics of the occluso-cervical height of 3 mm and a deep chamfer margin of 1 mm. Two plane reductions were followed for functional cusps. A 10° TOC was given to the first model and 20° to the second model. The dental procedures involved the use of a high-speed air rotor handpiece (manufactured by KaVo do Brazil Ind. Com. Ltd., Joinville, SC, Brazil), which was securely connected to a dental cast surveyor (3005 Surveyor Type A, produced by Dental Farm). The preparations were conducted using a round-end fissure diamond bur (102 R Shofu), which was tapered at angles of 10° and 20°. All the standardized preparations were checked with the help of a putty index sectioned in multiple directions (Affinis, Coltène/Whaledent). The anatomical preparations were rounded off and made without any lines or sharp points. Prior to printing the functional models, the taper was measured and verified using a computer system made up of a stereomicroscope with a USB CCD camera attached (Amscope, Irvine, CA, USA), a desktop computer, and a suitable measurement program (Version No. 3.7.12924) ([Figure 1](#)).

Modifications of the master model to include auxiliary features, 3-dimensional (3D) printed replica models, were generated from the 20° TOC master model so that the standardized taper and the preparations remained the same for the remaining groups. Verification was done in the same manner as for typhodont teeth. For scanning these models, a Bench Top Scanner (model number 4) manufactured by 3 Shape (Copenhagen, Denmark) was used. The working model from each group was 3D printed using the different 3D print resin liquid (Denta Model, Asiga, Alexandria, Australia), a digital light processing 3D printing machine (Asiga 3D printer, Alexandria, Australia, serial number 70B3DS5362C6A, model number PN01233), and printing parameters of 50 micrometer layer thickness, 2.975 s exposure time, and 0° printing orientation after the models had been scanned. The base’s design was modified so that it was compatible with the dimensions and arrangement of the holding clamp used by the universal testing machine. A mid-buccal

![Figure 1](image-url)
groove was provided on one of the printed working models and had dimensions of 1-mm width and depth and terminated 0.5 mm above the finish line. A 1-mm diameter cylindrical diamond bur was oriented vertically and was used to provide the groove. Another printed model was used to provide a proximal box on the distal side and had the same details as the groove, but the width increased to 3 mm (Figure 2). All the preparation and modifications were done by a single operator (A.P.) after practicing on many models. All the working models were generated from these 4 master models, with different features. The study comprised 8 groups, each containing 10 samples (Table 1).

![Figure 2. Standardized resin dies after typhodont teeth preparations with 20-degree taper along with mid-buccal groove and distal proximal box. (A, B) insets showing close view of the groove and the box preparations. The photograph was captured with a Canon EOS 700D digital single-lens reflex camera equipped with a 100-mm macro lens. A ring flash may have been used, and the photograph was then compiled using MS PowerPoint, version 20H2, on Windows 11 Pro, developed by Microsoft Corporation.](image)

Table 1. Description of zirconia and metal crown groups involving different preparation features in the study.

<table>
<thead>
<tr>
<th>Group</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.26</td>
<td>9.12</td>
<td>10.82</td>
<td>11.14</td>
<td>14.11</td>
<td>11.01</td>
<td>13.92</td>
<td>14.59</td>
<td>0.001*</td>
</tr>
<tr>
<td>SD</td>
<td>1.67</td>
<td>0.93</td>
<td>1.08</td>
<td>1.31</td>
<td>1.02</td>
<td>1.21</td>
<td>0.98</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>8.05</td>
<td>7.47</td>
<td>9.29</td>
<td>9.47</td>
<td>12.44</td>
<td>9.24</td>
<td>12.54</td>
<td>13.48</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>12.47</td>
<td>10.37</td>
<td>12.55</td>
<td>12.98</td>
<td>15.45</td>
<td>12.62</td>
<td>15.78</td>
<td>15.70</td>
<td></td>
</tr>
</tbody>
</table>

N – number of samples; SD – standard deviation, * P<0.001, statistically significant.

All the working models (40 for zirconia and 40 for metal) were 3D printed with changes in taper and the auxiliary features. Before being used in the study, each resin die sample was examined for appropriateness and integrity, and the model was scanned to create an STL file, which was then processed separately. After creating an occlusal ring with an external diameter of 5.5 mm and an interior diameter of 3.5 mm, the margin was set with a cement spacing of 50 μm and 40 samples of 3D-milled zirconia crowns (10 per group) were fabricated. Monolithic zirconia was used for the fabrication of the zirconia crowns (Ceramill Zolid PS, Amann Girrbach, ref 760257, lot 1708000, North America, LP, Charlotte, NC, USA). Forty samples of metal crowns (10 per group) were fabricated via the...
lost wax technique. CAD/CAM wax patterns with an occlusal ring of similar dimensions were made and 3D printed, and the printed model was invested and casted using the lost wax technique. Metal used for fabricating metal crowns were nickel-chromium alloys (Wiron Light, ref 50270, lot 73784, BEGO Bremer Goldschlägerei Wilh. Herbst GmbH & Co. KG., Bremen, Germany). The fit of each definitive crown was examined and verified on their respective models. All the crowns fabricated were checked for any inaccuracies and were replaced by new ones if found faulty.

**Cementation of Definitive Crowns**

Glass ionomer cement (RIVA Glass Ionomer luting cement, SDI Germany GmbH, Cologne, Germany, lot M210815) was the material of choice for the cementation process. The crowns (n=10) of each subgroup were cemented to the corresponding models and were secured for 5 min with a force of about 2.5 kg. Once the initial setting had been completed, extra cement was taken out with an explorer (Figure 3).

**Ageing of Samples and Pull-Off Testing**

The thermocycling equipment (Model 1100, SD Mechatronik, Bayern, Germany) was used to thermocycle the cemented definitive crowns for 10,000 cycles between baths held at 5°C and 55°C (15 s each), with a dripping period of 10 s and a transfer time of 5 s, to simulate a year in the oral environment (Figure 4).
A universal testing device (Instron System ID 5967L1040; model number 5967, Norwood, MA, USA) was then used to evaluate retention under tension with a crosshead speed of 5 mm/min on all samples (Figure 5). Pull-off testing was performed on all 80 samples until crowns were dislodged, and the tensile force in newtons (N) was recorded. In other research [32,33], the retention of crowns was tested using a comparable crown pull-off test with universal testing equipment. The retentive strength of crowns was evaluated based on a variety of characteristics in a few earlier studies [34,35]. These earlier studies used standardized metal dies that were comparable to the models that were 3D printed for this investigation.

Statistical Analysis

All tensile force values recorded during the tests for all specimens were recorded in a Microsoft Excel sheet (Microsoft Excel, USA). Subsequently, the collected data underwent a process of refinement and coding before being loaded into the statistical program SPSS Version 25.0 (IBM Corp., Armonk, NY, USA). The retentive strengths of all definitive crowns, along with crowned tapers and auxiliary features, were evaluated using one-way ANOVA. The post hoc Fisher least significant difference test was used to compare groups A1 to B4 between themselves. A 95% confidence interval calculation was also made. In all compared statistical tests, a significance level of \( P < 0.05 \) was used to determine statistical significance.

Results

The present study was conducted to visualize the effect of the change in TOC as well as the effect of the auxiliary features, namely, buccal groove or proximal box, on the retentive competencies of the definitive zirconia and metal crowns. Table 2 demonstrates the means and standard deviations (SDs) of all groups. The mean difference was highest in group B4 (mean=14.59 and SD=0.85), while it was lowest in group A2 (mean=9.12 and SD=0.93). The result of one-way ANOVA found a statistically significant difference among the groups (\( P < 0.001 \)). Overall, the retentive values were higher for the metal crowns than for the zirconia crowns. Within the groups, the highest retentive values were found for the 20° taper with proximal box preparation in both zirconia and metal groups, whereas the lowest values within groups were noted for the 20° taper group.

Table 3 presents the results indicating mean differences between the groups and multiple comparisons using the post hoc least significant difference test. Significant differences were observed in retention values between the groups, as indicated by the pull-off test. A strong negative correlation was found between groups A1, B3, and B4, while a positive correlation was identified between groups A1 and A2. Additionally, a statistically significant relationship was observed between groups A2 and A1 (\( P = 0.001 \)). Group A2 exhibited a negative
correlation with all other groups. Similarly, groups A3 and A4 showed a negative correlation with all groups, but both groups demonstrated a statistically significant difference with A2 (P=0.002). All groups demonstrated a strong negative correlation with B4, except for group B1 (mean difference=-0.48) and B3 (mean difference=-0.68), which showed a weak negative relation. Overall, these results imply that the 20° taper without box preparation showed lower retentive values. Figure 7 shows the confidence interval between the groups of zirconia and metal crowns. The result of this study showed that tooth preparation with a taper of 20° and a box preparation had the highest retentive value.

Discussion

The null hypothesis was accepted based on the inclusion of buccal grooves or proximal boxes, along with an increased TOC, which enhanced the retention of complete zirconia and metal crowns on molars with short preparations. In this in vitro research, we concluded that the highest retention of definitive crowns on teeth with short preparations was achieved with the preparation design featuring both a box and a groove as retentive features. The modified design, incorporating a proximal box as an auxiliary feature, exhibited superior retention values, compared with a buccal groove on preparations with a similar increased taper of 20° TOC. Additionally, the retentive values observed with a total occlusal convergence of 10° were lower than those of the box preparation group with 20° TOC.

The force values acquired for glass ionomer luting cement in this in vitro investigation exhibited notable differences, compared with the findings reported in the studies mentioned earlier in the literature [25,29,34,36]. The observed discrepancy may be attributed to variations in the standardization techniques used for the specimens, differences in the types of luting cement used, and variations in the model preparation materials. A review by Heintze indicated that resin cements generally yield better results than glass ionomer and zinc phosphate cements [32]. However, resin cement could not be used in our study due to the potential interaction with the resin dies, which could have resulted in atypical outcomes.

In the present study, the materials selected for the definitive restorations were zirconia and nickel-chromium alloy for metal crowns. The dies on which they were cemented were made of resin, which exhibits better resiliency than the metal dies utilized in prior studies [11,23,37,38]. While resin does not precisely mimic tooth tissues in the oral cavity, it still offers better resilience than other substitutes. It is impossible to replicate identical oral conditions in an in vitro study, making direct comparisons with real oral environmental outcomes challenging. However, examining the comparative effects of various features and situations remains significant for understanding clinical conditions. Additionally, the challenges associated with collecting intact natural teeth and the risk of fractures during testing were key reasons for not incorporating them into the

Figure 5. The universal testing machine demonstrates the connection of the test samples for the pull-off test, where the handles of the zirconia crowns are positioned to align with the sample handle in a perpendicular manner to the direction of the pulling force. The image was captured using a Canon EOS 700D digital single-lens reflex camera equipped with a 100-mm macro lens, either with or without a ring flash.

The box plot in Figure 6 depicts comparisons between the groups using the post hoc least significant difference test. The

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present study. Furthermore, dimensional variations in natural teeth could have potentially compromised the study results.

Studies have demonstrated the lack of retention in short-prepared teeth with a maximum taper of up to 25°, and improvement in retentive values with adding various auxiliary features [22,34,38,39]. The study by Prousseaef [23] has also proposed a reduction in the TOC at the cervical level, but such treatment is not conservative and cannot be used in vital teeth or teeth with compromised tooth structure. In the present study, the retentive qualities of the short preparations with reduced TOC varied when compared to the groove. However, the study by Vinaya et al [21] showed contrasting results when they compared the proximal grooves and the boxes and concluded that the groove provided a statistically significant increase in retention, compared with the boxes. In the study by Haritha et al, the addition of 1 horizontal groove on either side of a prepared tooth significantly increased the retention of the crown [40]. The boxes and the grooves prepared in the present study were vertically oriented. With the addition of auxiliary features like groove and box on preparations with increased TOC, the box preparation group showed improved retentive qualities. This is in accordance with the previous studies published [20,37,38].

In the study by Naik [38], 2 opposing boxes were used and compared to 2 opposing grooves. However, in his study, Weed [37] compared various preparations with single and multiple grooves and boxes and concluded box preparation was the most effective. Weed also mentioned that adding up to 3 grooves did not increase the retentive qualities. This can be attributed to more parallel walls and increased surface area, which increases the frictional resistance provided by the box preparation, compared with the groove. However, the study by Vinaya et al showed contrasting results when they compared the proximal grooves and the boxes and concluded that the groove provided a statistically significant increase in retention, compared with the boxes. In the study by Haritha et al, the addition of 1 horizontal groove on either side of a prepared tooth significantly increased the retention of the crown [40]. The boxes and the grooves prepared in the present study were vertically oriented. With the addition of auxiliary features like groove and box on preparations with increased TOC, the box preparation group showed improved retentive qualities. This is in accordance with the previous studies published [20,37,38].

All the groups receiving metal crowns had statistically significant differences with the corresponding groups of zirconia crowns. An interesting feature seen in our study was that the retentive quality of zirconia crowns on groove preparation was better than that of the 10° group; however, it was lower in the group receiving metal crowns. This can be attributed to the

Table 2. One-way analysis of variance showing inter-group comparison (in zirconia and metal crown groups) for retentive force values (in newtons).

<table>
<thead>
<tr>
<th>Group</th>
<th>Preparation Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>10° preparation models with Zirconia crowns</td>
</tr>
<tr>
<td>A2</td>
<td>20° preparation models with Zirconia crowns</td>
</tr>
<tr>
<td>A3</td>
<td>20° preparation models with mid-buccal groove and Zirconia crowns</td>
</tr>
<tr>
<td>A4</td>
<td>20° preparation models with distal proximal box and Zirconia crowns</td>
</tr>
<tr>
<td>B1</td>
<td>10° preparation models with metal crowns</td>
</tr>
<tr>
<td>B2</td>
<td>20° preparation models with metal crowns</td>
</tr>
<tr>
<td>B3</td>
<td>20° preparation models with mid-buccal groove and metal crowns</td>
</tr>
<tr>
<td>B4</td>
<td>20° preparation models with distal proximal box and metal crowns</td>
</tr>
</tbody>
</table>

Table 3. Post hoc Fisher least significant difference test showing differences in zirconia (A) and metal crown (B) group means and multiple comparison of pull-off force values (N).

<table>
<thead>
<tr>
<th>Group</th>
<th>A1 MD/P</th>
<th>A2 MD/P</th>
<th>A3 MD/P</th>
<th>A4 MD/P</th>
<th>B1 MD/P</th>
<th>B2 MD/P</th>
<th>B3 MD/P</th>
<th>B4 MD/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>X</td>
<td>1.14</td>
<td>-0.56</td>
<td>-0.88</td>
<td>-3.85</td>
<td>-0.75</td>
<td>-3.66</td>
<td>-4.34</td>
</tr>
<tr>
<td>A2</td>
<td>P=0.031*</td>
<td>X</td>
<td>-1.70</td>
<td>-2.02</td>
<td>-4.99</td>
<td>-1.89</td>
<td>-4.80</td>
<td>-5.47</td>
</tr>
<tr>
<td>A3</td>
<td>P=0.28</td>
<td>P=0.002*</td>
<td>X</td>
<td>0.67</td>
<td>3.32</td>
<td>0.19</td>
<td>3.10</td>
<td>3.78</td>
</tr>
<tr>
<td>A4</td>
<td>P=0.391</td>
<td>P=0.001*</td>
<td>P=0.530</td>
<td>X</td>
<td>2.97</td>
<td>0.13</td>
<td>2.78</td>
<td>3.45</td>
</tr>
<tr>
<td>B1</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.709</td>
<td>P=0.91</td>
<td>P=0.351</td>
<td>P=0.197</td>
</tr>
<tr>
<td>B2</td>
<td>P=0.150</td>
<td>P=0.001*</td>
<td>P=0.798</td>
<td>P=0.001*</td>
<td>X</td>
<td>2.91</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.717</td>
<td>P=0.001*</td>
<td>X</td>
<td>0.87</td>
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<tr>
<td>B4</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.001*</td>
<td>P=0.351</td>
<td>P=0.001*</td>
<td>P=0.197</td>
<td>X</td>
</tr>
</tbody>
</table>

* P<0.001, statistically significant; MD – mean difference.
Figure 6. Retentive force values (in newtons [N]) using post hoc least significant difference test shown via box plot.

Figure 7. A comparison using the 95% confidence interval between test groups of zirconia and metal crowns in relation to pull-off force.
multifactorial effect of the resin dies used and cement interaction with different restorative materials.

The present study focused on providing deep chamfer finish lines for all the preparations to reduce the exposure of cement, and a proper fit of the restorations was desired [41]. Further studies can be planned using CAD/CAM preparations and restorations, as well as different auxiliary features on resin dies and using different types of cement.

Strength and Limitations

This study was limited by factors such as single-tooth preparation and the lack of consideration of clinical factors, for example, tooth support or periodontal ligament support. Additionally, a single type of alloy was used. The rationale behind using resin material in this study was the high compressive strength and resilience of the base. Glass ionomer cement was used as a luting agent for resin material. However, the use of other cement might have changed the outcome. Hence, future in vitro studies should focus on the comparison of various cements in evaluating the retention of metal/ceramic crowns with a greater number of samples.

Conclusions

Within the limitations of the study, it can be concluded that increasing the TOC from 10° to 20° reduced the retentive quality of a complete coverage crown. Adding auxiliary features, such as grooves and boxes, increased the retentive values in a short-prepared tooth with a TOC of 20°. Box preparation on the proximal surface provided better retentive values than the groove on the buccal surface. Metalcrowns provided better retentive values than zirconia crowns, based on the die-cement-crown material interface. Incorporating proximal box preparation in an increased TOC of 20° improved the retentive values even better than the 10° TOC tooth with no modifications.

Department and Institution Where Work Was Performed

The work for the invitro study was done in the Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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