

## Seal capability of interim post and core crown with temporary cements

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**Abstract:** The purpose of the present study was to evaluate the *in vitro* seal capability of interim post and core crown restorations. Eighty teeth were selected and divided into 8 groups. Four experimental groups received interim posts and core crowns. Half of each group was decoronated at the cementum-enamel junction, groups PCCH and PCZO. The other half was sectioned 2 mm coronal to the cementum-enamel junction, groups PCrZO and PCrCH. The interim post and core crowns were luted with Rely X Temp NE, groups PCrZO and PCZO; Hydro C was used for Groups PCrCH and PCCH. The control groups, PC and PCr, received uncoated post and core crowns; groups OTg and OT were left without interim post and core crowns and were totally open. Infiltration was accessed by dye exposure followed by demineralization of the teeth. The length of the infiltration was measured using digital images taken from the specimens. The images were inserted into the Image Tool 3.0 software. Kruskal-Wallis analysis of variance and Dunn's multiple comparison method were used to test for significant differences among test groups ( $P < .05$ ). Groups PCrZO and PCrCH showed the least dye penetration, followed by groups PCZO and PCCH. Teeth restored with interim post and core crowns will be subject to leakage. Ethics Committee: 095/2008.

**Descriptors:** Dental leakage; Dental restoration failure; Post and core technique.

### Introduction

Coronal leakage has been cited as a primary cause of inflammatory periradicular pathosis due to the penetration of bacteria into the pulp space,<sup>1,2</sup> therefore, greater emphasis has been placed on the quality of final and interim restorations.<sup>3,4</sup> Delay in placing a restoration, fracture of a restoration, post space preparation, or restoration failure are some of the causes for loss of coronal seal after endodontic therapy.<sup>5</sup>

Custom made posts remain an integral component of the prosthodontics treatment,<sup>6-8</sup> especially when extensive loss of coronal tooth structure is found, and the classic extracoronary ferrule effect is suitable to improve the structural integrity of the pulpless tooth.<sup>9</sup> When such a restoration is used, an interim post and core crown is required while the definitive restoration is being constructed.<sup>10</sup> Therefore, not only should the criteria for construction and marginal accuracy be respected, but should also be regarded as important to seal the root canal system.<sup>11</sup>

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Provisional cements are used with interim restorations to provide a seal to prevent marginal leakage. They must be strong enough to retain the restoration but weak enough to enable removal of the restoration without causing damage to the abutment.<sup>12</sup> However, interim crowns luted with provisional cements are susceptible to cement washout, marginal leakage, bacterial infiltration, and caries, especially when placed for periods longer than a few weeks.<sup>13</sup>

Torabinejad *et al.*<sup>14</sup> (1990) found that bacterial recontamination along the entire length of a coronally unsealed root-filled tooth can occur within 19 days. Hence, the marginal accuracy of the interim post and core crown should be respected and an adequate provisional cement chosen. One might question the degree to which an interim post and core crown is capable of preventing penetration of bacteria into the root canal system while the patient is waiting for the final restoration.<sup>15</sup> Many authors have examined coronal microleakage with respect to gutta-percha root fillings and coronal plastic restorations,<sup>16</sup> but few have investigated to what degree coronal seal may be afforded by interim post and core crowns.

Therefore, the present study intends to examine the coronal seal achieved by interim post and core crowns cemented with two types of provisional cements currently used in the practice of prosthodontics, in ferruled and non-ferruled teeth. The null hypothesis was that there would be no statistically significant differences in infiltration between ferruled and non-ferruled teeth, nor between the two types of provisional cements.

## Material and Methods

This study was submitted to and approved by the Human Volunteers Research and Ethics Committee of the Piracicaba Dental School (095/2008). A total of 80 uniradicular anterior teeth with similar lengths, approximately 18-19 mm, were selected and randomly divided into 8 groups: four experimental groups, PCrZO, PCrCH, PCZO and PCCH (n = 10); and four control groups, OTg, PC, PCr, and OT (n = 10). Among the experimental groups, half were decoronated at the cementum-enamel



junction using a #3203 diamond bur (KG Sorensen, São Paulo, SP, Brazil) with continuous water cooling. The other half was sectioned coronally to the cementum-enamel junction, leaving 2 mm of intact tooth structure. Among the control groups, one group was left with 2 mm of intact tooth structure. The other three groups had their coronal structure removed at the cementum-enamel junction.

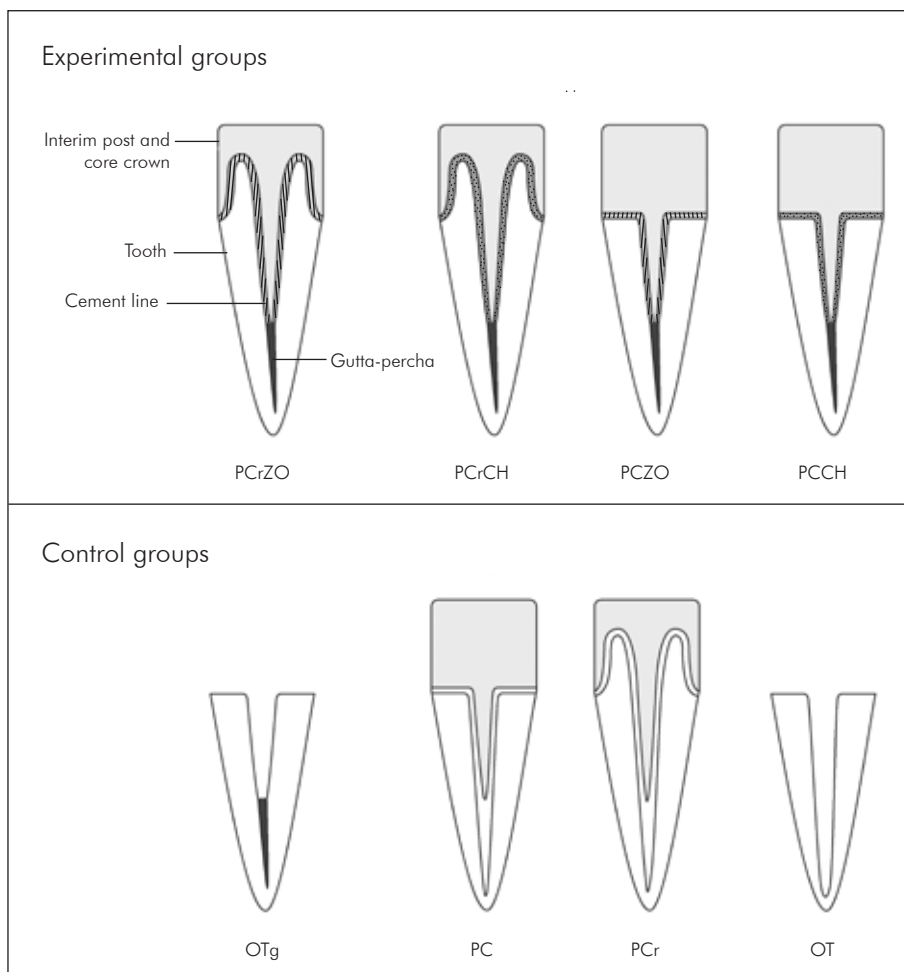
The experimental and control groups are illustrated in Figure 1. The two provisional cements used were Rely X Temp NE (3M/ESPE, St. Paul, Minn., USA), a zinc oxide non-eugenol cement, and Hydro C (Dentsply, International Inc., Milford, Del., USA), a calcium hydroxide-based cement.

Group PCrZO received interim post and core crowns cemented with Rely X Temp NE, and was left with 2 mm of coronal tooth structure above the crown margin. Group PCrCH received interim post and core crowns cemented with Hydro C, and was also left with 2 mm of coronal tooth structure above the crown margin. Group PCZO was restored with interim post and core crowns cemented with Rely X Temp NE, with no coronal tooth structure left above the crown margin. Group PCCH was restored with interim post and core crowns cemented with Hydro C, with no coronal tooth structure left above the crown margin. Group OTg was endodontically treated and was left totally open. Group PC was not endodontically-treated and received uncoated interim post and core crowns, and no coronal tooth structure was left above the crown margin. Group PCr was not endodontically treated, also received uncoated interim post and core crowns, and was left with 2 mm of coronal tooth structure above the crown margin. Group OT was left with ten control teeth totally open and was not endodontically-treated.

A single operator, who removed all the remaining pulpal tissues from the root canals, executed the endodontic procedures. Apical patency was determined using K-file #10 (Dentsply Maillefer, Ballaigues, Switzerland). The file was drawn back into the tooth until it was just visible at the apical foramen, and the working length was calculated to be 1 mm shorter than this. The sectioned root face was the reference point from which all measurements were

**Figure 1** - Experimental and control groups.

 Hydro C cement  
 Rely X Temp NE cement



taken. The canals were cleaned and shaped using Gates-Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland) from sizes 5 to 2 in a crown-down technique, followed by manual apical preparation with a size 45 file (K-file, Dentsply Maillefer, Ballaigues, Switzerland). All the canals were irrigated with 5 ml of 2.5% sodium hypochlorite (Biodinâmica, Ibiporã, CE, Brazil) between each instrument, and EDTA (Biodinâmica) was used before filling the root canals for groups PCrZO, PCrCH, PCZO, PCCH and OTg. The canals were filled with gutta-percha points (Odous, Belo Horizonte, MG, Brazil) and Pulp Canal Sealer (Kerr Corp, Orange, Calif, USA) using the warm compaction technique. A final radiography was taken to ascertain the quality of the obturation. Groups PC, PCr and OT were left without endodontic obturation.

Teeth for groups PCrZO, PCrCH and PCr were

prepared by a single operator using a round-end, diamond-tip bur #3145 (KG Sorensen, Barueri, SP, Brazil) and a high-speed handpiece under air-water spray. This was done to establish a chamfer finish line of 1.5 mm corresponding to the diameter of the bur at the level of the cementum-enamel junction; also, to establish an axial surface of coronal tooth structure of 2 millimeters 360 degrees around the circumference of the tooth preparation, to provide the ferrule effect. Groups PCZO, PCCH, OTg, PC and OT were prepared in the same way by the same operator, but without leaving coronal tooth structure above the crown margin.

Groups PCrZO, PCrCH, PCZO, PCCH and OTg had their gutta-percha removed at a length equal to 2/3 of the total length of the root using a largo reamer #2 (Dentsply Maillefer, Ballaigues, Switzerland). The correct length of the remaining api-

cal root canal filling was measured and confirmed by radiographs. Interim post and core crowns were constructed for groups PCrZO, PCrCH, PCZO, PCCH, PC and PCr. For that, paper clips were adjusted to fit the length of the root canal, leaving an extra portion to retain the interim crown. Retentions were added along the length of the clip and the internal area of the root canal was lubricated with petroleum jelly (União Química FTCA Nacional SA, São Paulo, SP, Brazil). A self-curing acrylic polymer (Duralay Dental Mfg Co., Worth, Ill, USA) was inserted into the canal together with the paper clip, and left to set. The crown was prepared by applying a block of acrylic resin in its doughy stage over the extra portion of the paper clip. Upon setting, the temporary post and core crown formed a single element. The external excess was removed with a maxicut bur #1521 (Edenta, Allschwil, Switzerland) and shaped to fit perfectly the finish line of the preparation. For groups PCrZO, PCrCH and PCr, the interim core crowns provided a hugging action, covering the 2 mm of the coronal tooth structure above the crown margin. For groups PCZO, PCCH and PC, the interim core crown was accommodated over the finish line of the preparation.

Groups PCrZO and PCZO had their interim post and core crowns coated with Rely X Temp NE; groups PCrCH and PCCH were coated with Hydro C. Both cements were mixed following the manufacturer's instructions in a controlled environment room, with temperature maintained at  $23 \pm 1^\circ\text{C}$ . All interim post and core crowns were cemented in place applying 5.0 kg pressure for 3 min, until the cement had set. Excess cement was removed using a hand instrument.

All teeth were wrapped in moist gauze with deionized water and stored in glass vials for 7 days in incubator, at a constant temperature of  $37^\circ\text{C}$ , with 100% humidity. After this period, the teeth were coated in sticky wax (Kerr Corp, Orange, Calif, USA) from the apex to the cementum-enamel junction, leaving the coronal face wax free. Each tooth was placed in a separate vial of dye at  $37^\circ\text{C}$  for 7 days. To remove any trapped air in the voids created by temporary cement dissolution, the teeth were submitted to 400 millimeters mercury vacuum pres-

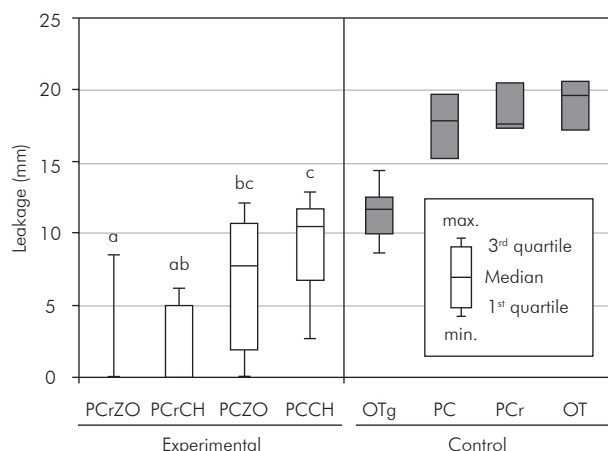
sure for three hours on both the first and the last days of dye infiltration.

After dye exposure, the teeth were rinsed in tap water, dried, and the sticky wax removed from the root surfaces. The teeth were submitted to demineralization in 5% HCl acid for 4 days, with daily changes.<sup>17</sup> The teeth were then cleaned with tap water and dehydrated by immersion for 24 h in 70, 80, 90 and 100% ethyl alcohol. Finally, the teeth were cleared and stored in methyl salicylate.

One specimen was photographed (DSC-F707, Digital Still Camera, Sony, MKM Minokamo, Japan) next to a millimeter ruler with the camera fixed on a tripod to standardize the position of the specimen and photo equipment. The image was inserted into the Image Tool 3.0 software (Department of Dental Diagnostic Science at The University of Texas Health Science Center, San Antonio, Texas, USA) to calibrate the measurement scale using the computer program. Next, all specimens were photographed the same way on their vestibular, lingual, mesial and distal faces, and the images were inserted into the same software. A single operator measured the extent of linear leakage on each face of the specimen, using a tool provided by the image tool software. Measurements were taken from the cementum-enamel junction, down the post channel, to the full depth of the dye penetration. The face having the greatest depth of penetration was used as the measure of infiltration. Data were analyzed by the Kruskal-Wallis test, and the Dunn multiple comparison was used as the *post hoc* test ( $\alpha = .05$ ).

## Results

It was noted that all groups showed coronal leakage of dye. As control groups do not represent any clinical situation in practice, a non-parametric statistical test, the Kruskal-Wallis 1-way ANOVA by ranks test ( $P < 0.001$ ), was applied only to the experimental groups to provide more statistical power to the study. Significant differences were found for the experimental groups. So, an all pairwise multiple comparison procedure using Dunn's method was applied. The results are depicted in the Boxplot distribution (Graph 1). Groups PCrZO and PCZO showed statistical differences between them



**Graph 1** - Length of dye infiltration for experimental and control groups. Equal letters on the experimental groups are not considered significantly different towards infiltration.

( $P < 0.05$ ), with median values of infiltration of 0 mm and 8 mm respectively. Groups PCrCH and PCCH also showed statistical differences between them, with median values of infiltration of 0 mm and 10 mm. However, no differences were found between PCrZO and PCrCH ( $P > 0.05$ ), between PCZO and PCCH, nor between PCrCH and PCZO. The length of dye infiltration observed for each control group, PC, PCr and OT, was between approximately 15 mm and 20 mm. These values were higher than any other group. However, the OTg group, also without clinical applicability, highlighted the effect of the endodontic obturation, showing values of dye infiltration varying between 9 mm and 15 mm. This was lower than the other control groups, but equal or higher than the worst experimental group (PCCH). Thus, this group became an intermediary group between the controls without cement and endodontic obturation and the experimental groups.

## Discussion

The results obtained from the experimental groups support rejecting the null hypothesis that there is no statistical significant difference in infiltration between ferruled and non-ferruled teeth. However, they do not support rejection when the type of cement is considered. The control groups were used for reference and, as expected, their results showed low variability. It was observed that teeth from the

groups PC and PCr showed similar results to those of the group OT. This similarity indicates that provisional cements, associated with interim post and core crowns in root-treated canals, work as a barrier toward infiltration and minimize leakage. This factor can be clearly seen when any experimental group is compared to the PC and PCr control groups, showing lower values of infiltration. The coronal tooth structure above the crown margin together with luted post and core crowns promoted a better seal. This is probably due to the more extended line of cement provided by the 2 mm of coronal tooth structure, causing the interim post and core crown to have a “hugging action”. This extracoronary bracing has been reported by many authors<sup>9,10</sup> to prevent fracture of the tooth structure when custom made posts and cores are used together with a cast crown. This is known as the ferrule effect, and in this case was responsible for a better seal.

The solubility of cements also plays an important role in providing a better seal. It can be considered a primary cause of failure of cast restorations, thus contributing to recurrent caries and/or loss of retention.<sup>13,18</sup> Heinemann *et al.*<sup>19</sup> (2006) found accidental bridge detachments with temporary cements to be rapid and frequent, and that improvements in retention and leakage can be attained by adding varnish to the temporary cements, thus reducing microleakage.<sup>20</sup>

Although the interim post and core crowns in the presented groups showed significant coronal leakage *in vitro*, the use of provisional cements, according to Markowitz *et al.*<sup>21</sup> (1992), may inhibit ingress of bacteria from the mouth and consequent infection of the root canal. However, sealed root canals can be recontaminated under several circumstances, such as breaking the seal of the temporary filling material, or if filling materials and/or tooth structures become fractured or dislodged. Fox and Gutteridge<sup>1</sup> (1997) showed that interim post and core crowns had significantly greater coronal leakage than prefabricated posts and casts. Their studies agree with Monday and Blais<sup>16</sup> (1985) who, in a study of interim acrylic crowns, noted poor marginal adaptation with this type of restoration. Also, Friedman *et al.*<sup>15</sup> (1986) noted that the amount of leakage associated

with interim restorations increased over time, and recommended using them for as short a time as possible. As shown by Torabinejad *et al.*<sup>14</sup> (1990), reinfection of root canals can be rapid and, in situations where post spaces are found, the reinfection can be even faster.<sup>22</sup> So, if temporary post and core crowns are lost, become dislodged, or are kept in place for an extended period of time, root canal retreatment should be considered.

Despite the limitations of the present work,<sup>23,24</sup> the results call attention to the care that must be taken with this type of restoration, both during and after endodontic therapy. As suggested by a literature review,<sup>4</sup> the prognosis of root canal-treated teeth can be improved by sealing the canal and min-

imizing the leakage of oral fluids and bacteria into the periradicular areas as soon as possible after the completion of root canal therapy. Therefore, dental structure should be preserved as much as possible when making custom made posts, and the interim post and core crowns should be used only for short periods.

## Conclusion

Teeth restored with interim post and core crowns will suffer leakage, and the length of the leakage depends on the amount of dental reminescent. Rely X Temp NE and Hydro C cement have similar sealing capability when used with interim post and core crowns.

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