Residual Dentin Thickness of Bifurcated Maxillary Premolars Following Two Post Space Preparation Methods

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\textbf{ARTICLE INFO} & \textbf{ABSTRACT} \\
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*Corresponding author: Maryam Forghani, Dental Material Research Center, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: +98-915 5143349 Fax: +98-511 8829500 Email: forghaniradm@mums.ac.ir & \textbf{Introduction}: The aim of this \textit{in vitro} study was to compare the effect of Gates-Glidden and Peeso reamer drills on residual dentin thickness during post space preparation in order to discover which method has minimum root structure damage. \textbf{Materials and Methods}: Thirty extracted human maxillary premolars with bifurcations at root middle were horizontally cut 15 mm coronal to the apical end after root canal treatment. The samples were scanned by Cone Beam Computed Tomography (CBCT) before and after preparing the post space. Residual dentin thicknesses were measured at 4-, 6-, and 8-mm levels from the apex. Data were analyzed using repeated measured ANOVA. \textbf{Results}: Endodontic therapy and post space preparations removed more dentin within the bifurcation of both roots compared to outer dentin. The difference in residual dentin thickness was highly significant regarding stage (before and after post space preparation) in all levels and stage \times device in coronal and middle levels (P<.05). This in vitro study emphasizes the minimal dentin width in the buccal root of maxillary premolars, especially near the bifurcation. \textbf{Conclusion}: Lack of adequate residual dentin thickness after post space preparation implies that the use of posts in maxillary first premolars should be limited. When mandatory, it is recommended that post space be prepared with Gates-Glidden drill in the palatal root of maxillary first premolars and use of Peeso reamer be avoided. \textbf{Keywords}: Bifurcated Maxillary Premolars; Cone-Beam Computed Tomography; Residual Dentin Thickness; Root Canal Therapy \\
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\textbf{Introduction}

Vertical root fractures (VRFs) occur mostly in endodontically treated and restored teeth [1]. Some factors such as excessive removal of dentin during root canal instrumentation [2, 3] and post space preparation [4] have been identified as causes of VRF. A drill with a non-cutting end such as Gates-Glidden or Peeso reamer, which will preferentially remove the softer gutta-percha rather than the canal wall dentin, should be used for post space preparation [5].

Location and direction of VRF are influenced by residual dentin thickness (RDT), external root morphology and canal curvature [6]. With regard to external root morphology, the roots with narrow mesiodistal diameter compared to the buccolingual dimension (such as maxillary and mandibular premolars) are most susceptible to fracture [7, 8].

The proximal root depression, the reduced wall thickness, and the decreased radius of curvature in the palatal aspect of the buccal root of maxillary premolars increase fracture susceptibility in these roots [9]. Post space preparation, especially in VRF-susceptible teeth, is very important because of their specific cross-section contours and curvatures [7, 10]. The residual dentin thickness after post space preparation should be a minimum of 1 mm around the entire circumference of the canal [11, 12]. Katz \textit{et al.} reported that post space preparation with ParaPost drills in the bifurcated maxillary premolars resulted in RDT values less than one millimeter in the palatal aspect of the buccal roots [13].

The aim of this \textit{in vitro} study was to evaluate and determine the residual dentin thickness in the bifurcated roots of maxillary premolars after post space preparation with Gates-Glidden burs or Peeso reamer drills.
Table 1. Means (SD) of residual dentin thickness (RDT) on each root canal wall and at 3 selected levels before and after post space preparation with Gates Glidden (group 1) and Peeso reamer (group 2)

<table>
<thead>
<tr>
<th>Root</th>
<th>Level</th>
<th>Root wall</th>
<th>Group 1</th>
<th>Group 2</th>
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<td></td>
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<td>Before (mm)</td>
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<td>1.99 (0.286)</td>
<td>1.92 (0.282)</td>
<td>1.95 (0.247)</td>
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<td>1.62 (0.271)</td>
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<td>1.61 (0.237)</td>
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<td>1.70 (0.194)</td>
<td>1.65 (0.181)</td>
<td>1.74 (0.308)</td>
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<td>1.49 (0.254)</td>
<td>1.45 (0.269)</td>
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<td>1.38 (0.178)</td>
<td>1.33 (0.201)</td>
<td>1.46 (0.201)</td>
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<td>1.47 (0.269)</td>
<td>1.40 (0.284)</td>
<td>1.56 (0.246)</td>
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<td>1.19 (0.285)</td>
<td>1.12 (0.281)</td>
<td>1.17 (0.106)</td>
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<td>0.95 (0.383)</td>
<td>0.83 (0.407)</td>
<td>1.11 (0.280)</td>
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<td>1.22 (0.229)</td>
<td>1.13 (0.258)</td>
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<td>1.37 (0.227)</td>
<td>1.21 (0.227)</td>
<td>1.32 (0.187)</td>
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<td>1.92 (0.287)</td>
<td>1.87 (0.243)</td>
<td>1.82 (0.271)</td>
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<td>1.49 (0.368)</td>
<td>1.43 (0.327)</td>
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<td>1.56 (0.232)</td>
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<td>1.22 (0.181)</td>
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<td>1.39 (0.234)</td>
<td>1.30 (0.221)</td>
<td>1.38 (0.196)</td>
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<td>1.20 (0.301)</td>
<td>1.04 (0.319)</td>
<td>1.25 (0.332)</td>
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<td>1.45 (0.307)</td>
<td>1.33 (0.261)</td>
<td>1.42 (0.320)</td>
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<td>1.27 (0.272)</td>
<td>1.09 (0.494)</td>
<td>1.14 (0.163)</td>
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<td>1.41 (0.277)</td>
<td>1.16 (0.246)</td>
<td>1.29 (0.244)</td>
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Material and Methods

All procedures in this study were carried out according to protocols approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran. Thirty human bifurcated maxillary first premolars were collected from patients who were orthodontically extracted. The inclusion criteria were closed apices, free from caries, restorations and furcation obstruction. In all the teeth, the bifurcation was not located more apically than the middle third of the root. After extraction, the teeth were immersed in 5.25% NaOCl for 30 min in order to disinfect them. Two x-ray images were obtained from the buccal and mesial surfaces to record furcation anatomy.

Root Canal Preparation

Root canal preparation was performed by one practitioner. Access cavities were prepared with a diamond bur. The working length was determined by insertion of a #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until the file tip was just visible at the apical foramen and then 0.5 mm was subtracted from the measured length. A standardized step-back technique using K-files was used. Each root canal was enlarged to #35 apical file with 2.25% NaOCl irrigation. After canal instrumentation, all specimens were dried with absorbent paper points and filled with gutta-percha (Aria Dent, Tehran, Iran) and root canal sealer (AH-Plus, Dentsply De-Tray, Konstanz, Germany) using cold lateral condensation technique. Gutta-percha was removed to 5 mm of the working length with a heat carrier. The crowns were then cut off with a diamond disk so that the remaining length was adjusted to 15 mm. All the roots were embedded in acrylic blocks. After resin setting, a groove was made to mark the buccal root location and the blocks were mounted on a dental arch.

Residual Dentin Thickness (RDT) Measurement

To evaluate the samples using CBCT, they were mounted in putty (Exaplast Set, Detax, Ettlingen, Germany). The exposure conditions of CBCT (Promax, Planmeca, Helsinki, Finland) set in image scanning were: MA=8; KVP=72; high resolution. The center of the buccal root canal from coronal aspect was determined as zero point using Romexis software (Planmeca, Helsinki, Finland). Dentin thickness of both roots was measured at 4, 6 and 8 mm apical to this point. Measurements were made at 4 points (buccal, palatal, mesial and distal). After post space preparation, the teeth were returned to the putty frame and RDT was re-measured in the same manner previously described.

Post Space Preparation

After initial scanning, the samples were randomly divided into two groups, mounted in a dental arch and then fixed on a phantom head. Post spaces were prepared in the coronal 10-mm of root canals with #2 and #3 Gates-Glidden burs (Dentsply, Maillefer, Switzerland) in group 1 and #1 and #2 Peeso reamer drills (Dentsply, Maillefer, Switzerland) in group 2.

Statistical Analysis

ANOVA tests with repeated measures were used to determine significant differences in RDT between the various procedures at each root level with different measurement directions. Statistical significance was set at P<0.05.
**Figure 1.** Mean RDT of root walls in relation to the aspect, stage, root and instrument type in coronal level from left to right: aspect code (B: Buccal, P: Palatal, M: Mesial and D: Distal), stage code (1: before and 2: after preparation) and root code (B: Buccal and P: Palatal root); GG: Gates Glidden; PR: Peeso Reamer

**Results**

In some slices, the buccal and palatal roots were not completely divided; therefore, measurements were made for the buccal, mesial and distal aspects of the buccal roots, and for the palatal, mesial and distal aspects of the palatal roots.

Means and standard deviations for RDT on each root canal wall at sectioned levels before and after preparation of post space preparation is shown in Table 1. Some apical slices had to be discarded due to blurred CBCT images. In all slices, the RDT of the mesial aspect was thinner than the distal aspect. In the apical slices, the inner walls were thinner compared to the outer walls.

Four-way ANOVA results with repeated measures for the independent variables stage (before or after post space preparation), aspect (M, B, D, P), root (B, P) and instrument (GG or P) are shown in Figures 1-3. In all of the sections, differences were significant with regard to stage \((P<0.000)\) and aspect \((P<0.05)\). Differences in RDT were also significant for root variable in the coronal and middle sections \((P<0.05)\). The interactions of stage \(\times\) instrument in coronal sections, stage \(\times\) instrument and aspect \(\times\) root in the middle sections and aspect \(\times\) root in the apical sections were also significantly different. The three and four-way interactions between variables were not statistically significant.

**Discussion**

The residual dentin thickness after root canal and post space preparation is very important. Excessive removal of radicular dentin weakens the root [14] and might result in perforations and VRF [15-17]. The most common form of the maxillary first premolar is the two-rooted form [18], and in the most of two-rooted teeth, furcation area is located in the middle third of them [19], therefore, the present study was conducted on two-rooted maxillary first premolars with bifurcation in the middle third.
After post space preparation, mean RDT of the palatal aspect of the buccal root in the apical sections was less than the recommended 1 mm (0.75 and 0.86 mm in groups 1 and 2, respectively). These values correspond to RDT values of 0.82 – 0.9 mm reported by Pilo et al. [21] and 0.68 mm by Katz et al. [13]. The slight difference in mean values might be attributed to the more coronal or apical location of the slice in these studies.

Minimal RDT values, before and after dowel preparation, were also recorded in the palatal walls of the buccal roots (0.45 and 0.36 mm, respectively), consistent with Pilo et al.'s results [21]. Mean reduction in RDT after dowel preparation was also greater in this aspect (0.2 and 0.25 mm in groups 1 and 2, respectively). In the apical sections in which the buccal and palatal roots were completely divided, the inner aspects of both roots were thinner compared to the outer aspects, consistent with the results of previous studies [13, 21]. Pilo et al. mentioned that the furcation groove in the buccal root and the divergence of the canal below the bifurcation point in the palatal root may be responsible for this significant interaction [21].

The significant interaction of stage × instrument in the coronal and middle sections implied that decrease in RDT is dependent on the instrument type. G.G with shorter blade and thinner shaft is more flexible compared to Peeso reamer. Furthermore, it is assumed that the shorter spiral cutting blades of GG might reduce dentinal contact and result in greater RDT after post space preparation.

**Conclusion**

The clinician should be aware of specific natural anatomy in bifurcated maxillary first premolars because even a conservative approach in post space preparation might jeopardize root integrity. In buccal roots, dowel preparation should be avoided where possible. When post space preparation is mandatory, it seems that the use of Gates-Glidden drills is preferable to Peeso reamers.

Conflict of Interest: ‘None declared’.

**References**


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