

# The Influence of Apical Enlargement on the Danger Zone Dentin Thickness of the Mesial Root Canals of Mandibular First Molars

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## INTRODUCTION

Root canal infection remains a leading cause of endodontic failure, highlighting the need for thorough cleaning and disinfection of the root canal system. Mechanical preparation is essential for shaping the canal, so that irrigants can disinfecting areas that instruments cannot reach. Larger apical diameters have been linked to improved irrigant penetration, enhanced debridement and better clinical outcomes. However, excessive removal of dentine is especially critical in anatomically constrained areas such as the distal aspect of the mesial root of mandibular molars—the so-called danger zone—may compromise tooth structure and reduce its fracture resistance. Therefore, the aim of the present study was to evaluate the influence of apical enlargement on the thickness of the danger zone dentin in the mesial root canals of mandibular first molars. This assessment was conducted using a stepwise and non-destructive micro-CT imaging methodology.

## METHODOLOGY

Ten mesial root canals from five different mandibular molars were selected and instrumented sequentially until ProTaper Next X2 (25/.06v), X3 (30/.07v) and X4 (40/.06v) following the manufacturer's recommendations. A micro-CT scan was conducted pre-operatively and after each one of the final enlargements. The danger zone dentin thickness assessment was evaluated using a two-dimensional (2D) analysis with DataViewer software. The furcation level was first determined at the point where both roots were individualized, then, using the software ruler, the dentin wall thickness of the danger zone (distal wall) in the mesial roots of the molars was measured at 2-, 3- and 4-mm levels below the furcation. Three measurements were taken for each assessment and the average was calculated and reported in millimeters. ANOVA with Bonferroni correction test was used for comparisons. The statistical significance level was set at 0.05.

## RESULTS

Root canal - Area	Pre-operative	25/.06v (ProTaper Next X2)	30/.07v (ProTaper Next X3)	40/.06v (ProTaper Next X4)
<b>2mm below furcation</b>				
MB-Danger zone (mm)	1.00 <sup>a</sup> ±0.20 [0.75-1.29] 0.97 [0.37]	0.75 <sup>b</sup> ±0.19 [0.43-1.04] 0.72 [0.32]	0.68 <sup>c</sup> ±0.23 [0.31-1.02] 0.61 [0.38]	0.62 <sup>d</sup> ±0.19 [0.31-0.90] 0.53 [0.32]
ML -Danger zone (mm)	1.09 <sup>a</sup> ±0.25 [0.57-1.39] 0.99 [0.24]	0.73 <sup>b</sup> ±0.20 [0.45-1.04] 0.75 [0.34]	0.66 <sup>c</sup> ±0.20 [0.35-0.96] 0.63 [0.32]	0.61 <sup>d</sup> ±0.20 [0.33-0.92] 0.59 [0.28]
<b>3mm below furcation</b>				
MB-Danger zone (mm)	0.99 <sup>a</sup> ±0.26 [0.69-1.57] 0.94 [0.35]	0.82 <sup>b</sup> ±0.28 [0.53-1.47] 0.70 [0.37]	0.73 <sup>c</sup> ±0.29 [0.45-1.41] 0.66 [0.37]	0.66 <sup>d</sup> ±0.30 [0.37-1.41] 0.57 [0.36]
ML -Danger zone (mm)	0.93 <sup>a</sup> ±0.20 [0.67-1.33] 0.91 [0.14]	0.75 <sup>b</sup> ±0.21 [0.47-1.14] 0.72 [0.24]	0.65 <sup>c</sup> ±0.17 [0.41-1.06] 0.65 [0.15]	0.59 <sup>d</sup> ±0.18 [0.35-0.98] 0.58 [0.24]
<b>4mm below furcation</b>				
MB-Danger zone (mm)	0.97 <sup>a</sup> ±0.26 [0.51-1.37] 0.99 [0.39]	0.83 <sup>b</sup> ±0.20 [0.43-1.04] 0.89 [0.34]	0.75 <sup>c</sup> ±0.20 [0.37-1.00] 0.81 [0.33]	0.71 <sup>c</sup> ±0.21 [0.37-0.98] 0.78 [0.34]
ML -Danger zone (mm)	0.85 <sup>a</sup> ±0.20 [0.55-1.26] 0.83 [0.11]	0.73 <sup>b</sup> ±0.19 [0.43-1.04] 0.71 [0.25]	0.66 <sup>c</sup> ±0.18 [0.37-0.98] 0.66 [0.21]	0.63 <sup>d</sup> ±0.19 [0.35-0.98] 0.63 [0.20]

Table 1: Mean and standard deviation [minimum and maximum limits] plus median [interquartile range] of danger zone dentin thickness measured in the axial 2-, 3- and 4-mm below furcation before and after the sequential root canal enlargement analyzed by micro-CT.

MB: Mesio Buccal canal  
ML: Mesio Lingual canal  
Different superscript letters represent statistically significant differences (p<0.05) between instruments in a specific root location (within lines)

## CONCLUSION

In conclusion, when moving apically, the dentin thickness in the danger zone tends to decrease in both mesio Buccal and mesio Lingual canals. At 2 mm and 3 mm below the furcation level, a more significant reduction in dentin thickness is observed in the danger zone compared to the dentin thickness at 4 mm below the furcation level. At this point, the differences become less noticeable. Overall, the decrease in dentin thickness is more pronounced in the danger zones, particularly at a depth of 2 mm below the furcation. These differences are more prominent in the mesio Buccal canal than in the mesio Lingual canal, although both show a similar trend.

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