



Research article

An efficacious horizontal angulation separated radiographically superimposed canals in upper premolars with different root morphologies

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ARTICLE INFO

Keywords:

Dentistry
Dental materials
Periodontics
Oral medicine
Prosthetic dentistry
Radiology
Endodontic treatment
Prosthodontic treatment
Radiograph
Upper premolar

ABSTRACT

Objectives: To determine the effect of various horizontal beam angulations on radiographically separating superimposed canals in upper premolars with different external root morphologies.**Materials and methods:** The independent variables were 1) three different external root morphologies of upper premolars (n = 30); one-root (A), fused-root (B) and two-root (C), 2) thirteen angulations (0° and mesial (Ms) and distal (Ds) shifts of 15, 20, 25, 30, 35, and 40°), and 3) the superimposed canal at the apex (apx) and 5-mm from the apex (5apx). The dependent variables were the percentage of radiographs demonstrating canal separation. The separated canal distances were analysed using analysis of variance (ANOVA) and Tukey HSD.**Results:** Separation distances at apx and 5apx on one-root, fused-root and two-root premolar radiographs increased as the angulation increased. Ms angulations generated a higher separation distance (SepDist) in mm compared with the Ds angulations. Significantly different separation distances were observed from various horizontal shift angulations (p < 0.05). Percentage of canal separation from 0° was achieved differently in different morphology of upper premolars (14–80%) at apx and 10–40% at 5apx. The 20–40Ms/Ds and 25Ds/30–40Ms/Ds resulted in 100% of radiographs with canal separation for two-root and fused-root premolars, respectively, at apx and 5apx. Only the 35/40Ms resulted in 100% of radiographs with separation at apx in one-root teeth.**Conclusion:** The ideal horizontal angulation which revealed the superimposed canal at the apx/5apx for one-root, fused-root, and two-root teeth are 35M/35M, 20D/20M, and 15M/20M, respectively.**Significance:** The 25Ms was the optimal angulation which strongly recommended with the highest probability of separation and acceptable image quality in endodontic and prosthodontic treatment for unknown morphologies evaluated.

1. Introduction

Understanding tooth anatomy and root canal morphology are essential for successful root canal treatment [1] and subsequent tooth restoration [2]. Treatment failure commonly results from root canal morphology variation, and two-dimensional radiographs do not always reveal superimposed untreated canals and the amount of 4–5 mm apical gutta-percha seal.

The root morphology of upper first premolars varies, with three-root (0–6%), one-root (10–49.4%) and two-root (50.6–85%) teeth observed. Two-root premolars present as fused-root (13.5–33%) and distinct root or two-root teeth (18.5–57%) [3, 4, 5, 6, 7]. Predominant root morphology also demonstrates ethnic variability towards one root [8, 9] and two roots [4, 5, 7, 9, 10, 11, 12]. In contrast, upper second premolars most

commonly have one root (55.3–90.3%), with 9.7%–44.2% found to have two roots. The prevalence of three roots in these teeth is extremely low (0.3–0.46%) [1, 13, 14].

Previously, superimposed root canals on radiographs can be separated by changing angle from either mesial or distal horizontal direction using buccal object rule [15, 16, 17]. Irrespective of root morphology, mesial horizontal angulations of 20° [6,18], 25° [19], 30° [20] and 40° [18] separated superimposed canal in upper premolars. The authors hypothesized that upper premolars with different root forms might require specific mesial or distal horizontal angled radiographs to separate superimposed canals. Then, the objective was to determine the effect of various horizontal beam angulations on radiographically separating superimposed canals in upper premolars with different external root morphologies at the apex and 5-mm from the apex.

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<https://doi.org/10.1016/j.heliyon.2020.e04294>

Received 28 January 2019; Received in revised form 15 April 2019; Accepted 19 June 2020

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