

Influencing factors of orthodontic tooth movement and root resorption, and evaluation of its radiographic diagnostic means

Akademisk avhandling

Som för avläggande av odontologie doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentlig försvaras i Arvid Carlsson, Odontologen, Medicinargatan 12D, den 28 november, klockan 9:00.

av

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Avhandlingen baseras på följande delarbeten

- I. **Dudic, A.**, Giannopoulou, C. & Kiliaridis, S. (2013) Factors related to the rate of orthodontically induced tooth movement. *Am J Orthod Dentofacial Orthop*, 143, 616-21.
- II. **Giannopoulou, C.**, Dudic, A., Pandis, N. & Kiliaridis, S. (2016) Slow and fast orthodontic tooth movement: An experimental study on humans. *Eur J Orthod*, 404-8.
- III. **Dudic, A.**, Giannopoulou, C., Leuzinger, M. & Kiliaridis, S. (2009) Detection of apical root resorption after orthodontic treatment by using panoramic radiography and cone-beam computed tomography of super-high resolution. *Am J Orthod Dentofacial Orthop*, 135, 434-37.
- IV. **Dudic, A.**, Giannopoulou, C., Martinez, M., Montet, X. & Kiliaridis, S. (2008) Diagnostic accuracy of digitized periapical radiographs validated against micro-computed tomography scanning in evaluating orthodontically induced apical root resorption. *Eur J Oral Sci*, 116, 467-72.
- V. **Dudic, A.**, Giannopoulou, C., Meda, P., Montet, X. & Kiliaridis, S. (2017) Orthodontically induced cervical root resorption in humans is associated with the amount of tooth movement. *Eur J Orthod*, 1-7.

**SAHLGRENKA AKADEMIN
INSTITUTIONEN FÖR ODONTOLOGI**



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Abstract

Aims: To investigate whether patient- or tooth-related factors like jaw location or intra- and interarch obstacles influence the amount of orthodontic tooth movement and orthodontically induced root resorption, and to evaluate if the concept of slow and fast movers is valid in humans. Furthermore, to evaluate the validity of different radiographic methods for detecting root resorption.

Patients and methods: A standardized experimental split mouth model for orthodontic tooth movement was used in 30 subjects, 59 premolars were moved buccally during 8 weeks with the application of 1 N force and 58 contralateral premolars served as controls. The amount of tooth movement was evaluated with digitized superimposed plaster models. At the end of the experimental period the teeth were extracted, scanned in a micro-CT scanner, and a volumetric evaluation of resorption craters at the cervical part of the root was performed. The possible influencing factors studied were age, location (maxilla/mandible), and presence or absence of intra- or interarch obstacles. Standardized periapical radiographs, taken before and after the experiment, were evaluated for apical root resorption and compared with the micro-CT scanned images. In a different sample of 275 teeth in 22 patients near the end of an orthodontic treatment with fixed appliances, apical root resorption was evaluated in panoramic radiographs (OPT) and compared to the corresponding cone-beam CT images (CBCT).

Results: Younger subjects (<16 years) showed greater amount of tooth displacement compared with older subjects (≥ 16 years): 2.68mm vs. 1.84mm ($P < 0.01$). When an intra-arch or interarch obstacle was present, the amount of tooth movement was significantly less (1.86mm vs. 2.67mm) ($P < 0.05$). Teeth moved to a greater amount in the maxilla compared to the mandible but the displacement varied substantially between individuals (0.6–5.8mm) and was highly correlated within the same individual ($R = 0.88$, $P < 0.001$). Higher amount of cervical root resorption was detected in orthodontically moved teeth (0.00055mm^3) compared to controls (0.00003mm^3 ; $P < 0.001$). A moderate correlation was found between root resorption in the two experimental teeth within the same individual ($R = 0.42$, $P = 0.02$). Root resorption was greater in the mandible than the maxilla. The amount of root resorption was correlated with the amount of tooth movement ($R = 0.31$, $P = 0.01$). The comparison of the apical radiographs and the micro-CT scanner showed less accuracy in the conventional radiograph. Panoramic radiographs underestimated apical root resorption as compared to the more precise CBCT 3D images.

Conclusions: A wide range of tooth displacement revealed slow and fast movers. Intra- or interarch obstacles decreased the amount of tooth movement. Younger patients showed greater tooth movement velocity than older ones. Application of 1N over 8 weeks may provoke notable root resorption, which varied widely between and within subjects. A part of this variation was attributed to the location and the amount of tooth movement. Conventional radiologic methods underestimated root resorption. CBCT might be a useful complementary diagnostic method to conventional radiography that can be used in cases where diagnostic precision is needed.

Keywords: orthodontic tooth movement, orthodontically induced root resorption, radiologic evaluation of root resorption