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Effects of mechanical force application on the developing root apex in rat maxillary molars

Names of Authors and institutions

All conflicts of interest must be disclosed
(Not necessary to describe items with "Nil")
・Not necessary to write the amount of funding associated with a conflict of interest

COI Disclosure: The authors have no financial conflicts of interest to disclose concerning the presentation.

or

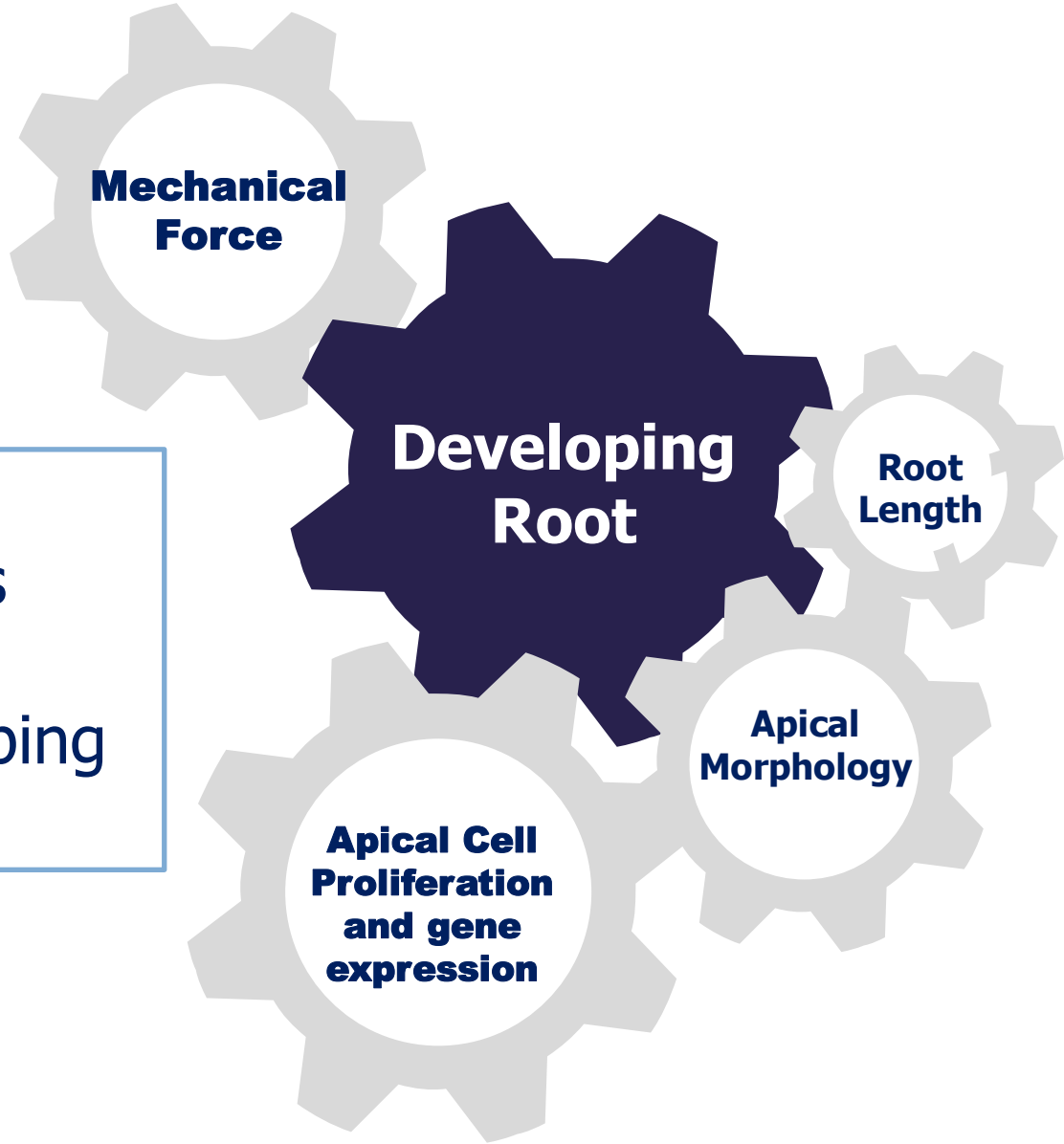
COI Disclosure: Advisory role; Stock ownership/profit; Patent royalties/licensing fees; Lecture fees; Manuscript fees; Trust research/joint research funds; Scholarship fund; Affiliation with Endowed Department; Other remuneration such as gifts

Introduction

The developing root apical tissues are believed to maintain their developmental capability to form the tooth root and periodontal tissue in vivo, and exhibit higher proliferation and mineralization potentials than the adult dental pulp tissue in vitro. The developing root apex is one of the parts most susceptible to radicular morphogenesis and affected by genetic and extrinsic factors. Mechanical force naturally happens during physiological eruption of permanent teeth in case of insufficient space and premature contact with the antagonistic teeth. It is also widely applied during early orthodontic treatment for young patients who have immature permanent teeth with developing root apex. Therefore, studies should be well-designed to explore the effects of mechanical force application on developing root apex comprehensively.

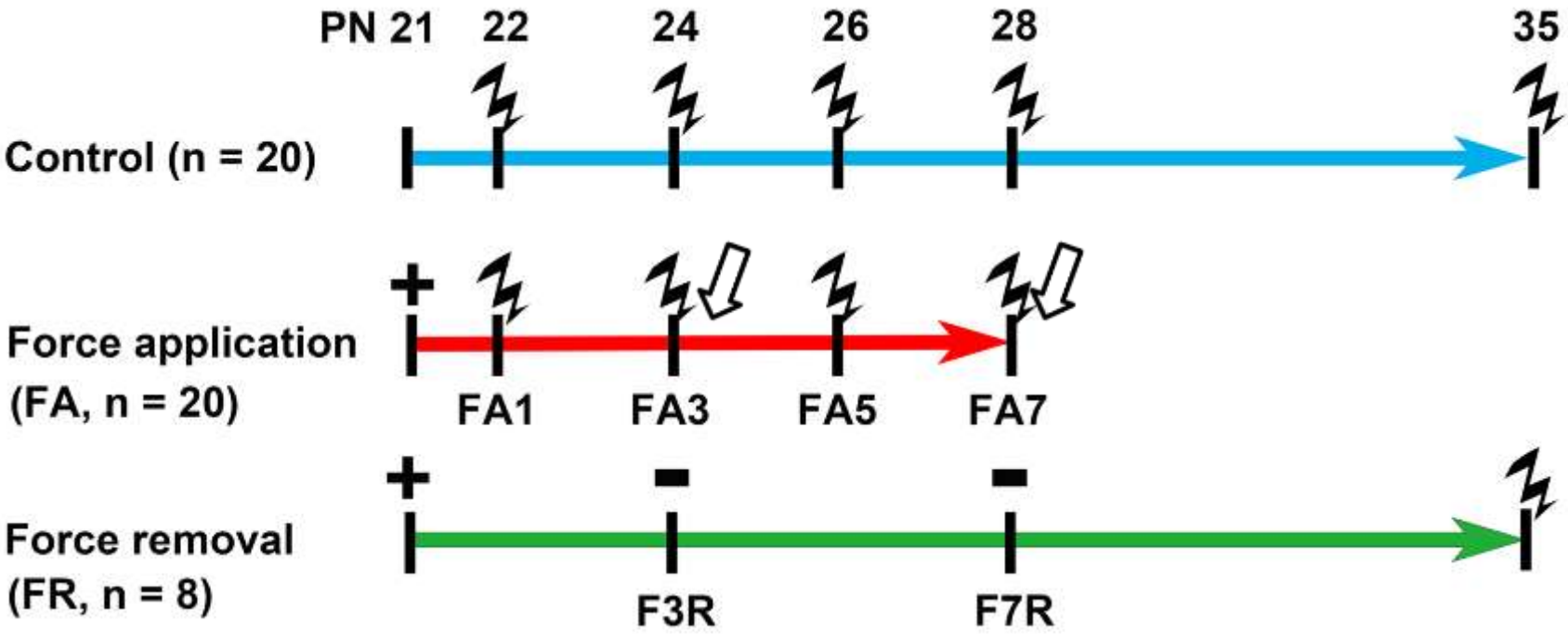
Objectives

Our study aims to investigate the effects of mechanical force application on developing root apex in vivo.



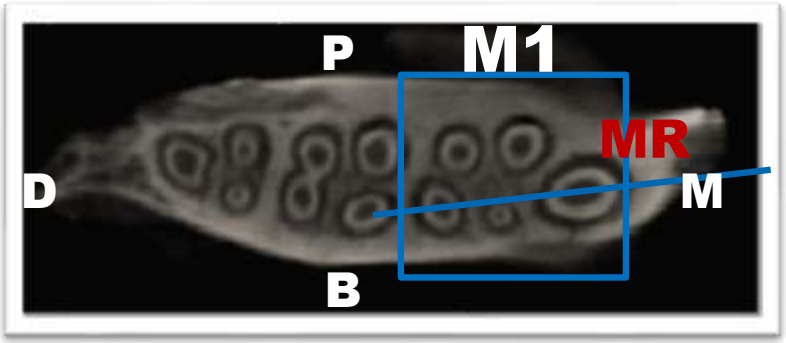
Materials and Methods

Animal procedure schedule



Micro-focus X-ray computed tomography

Measurement of the M1 mesial root



Root Length

cRA: centre of the root apex
CEJ: cemento-enamel junction

Hematoxylin and eosin (HE) staining

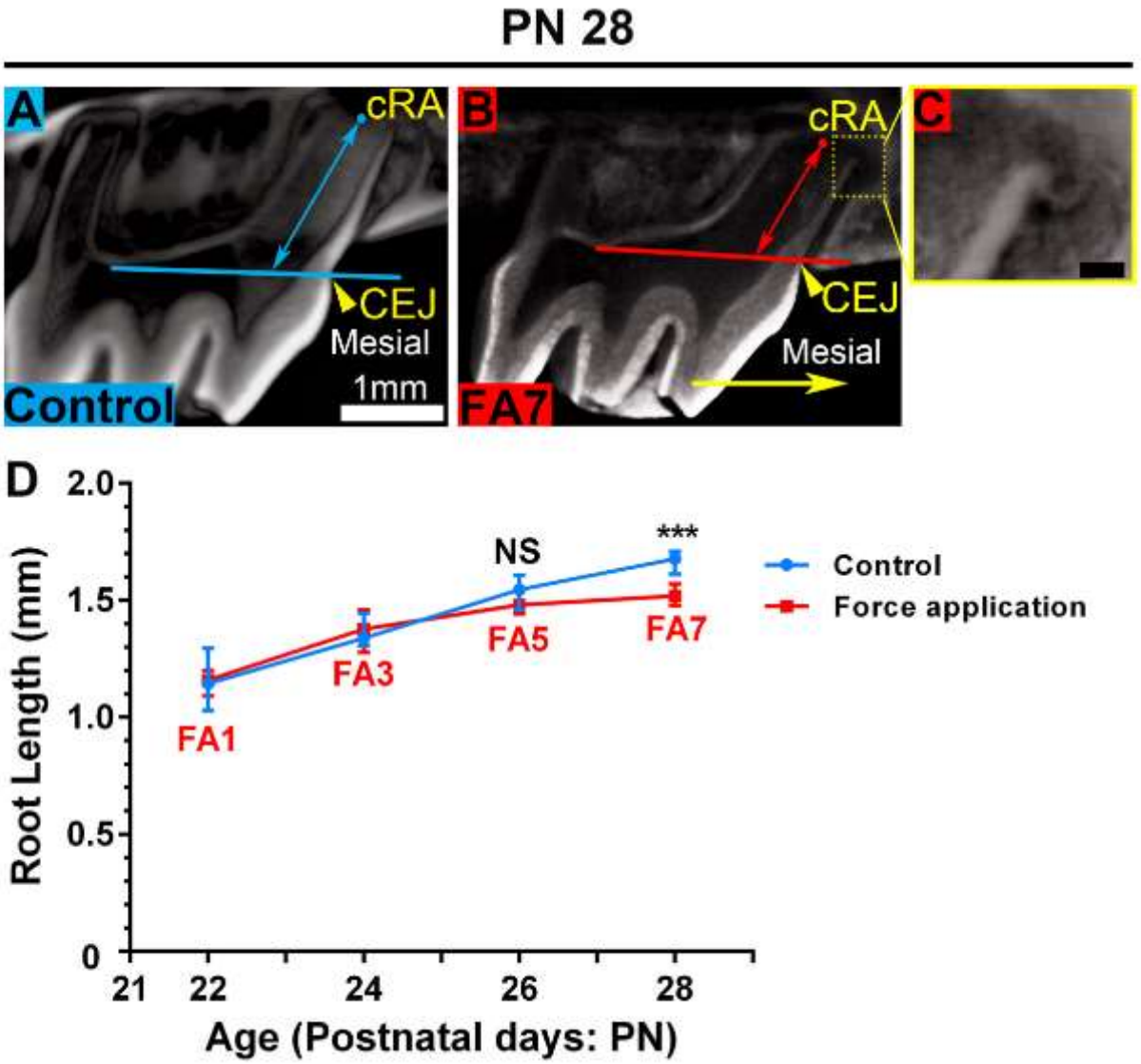
Immunohistochemistry

Keratin Pan: A maker of dental epithelial cells along the developing root.

Laminin: One of the adhesive glycoproteins, which interacts with proteins anchored in the plasma membranes of the cells relaying biochemical and mechanical signals.

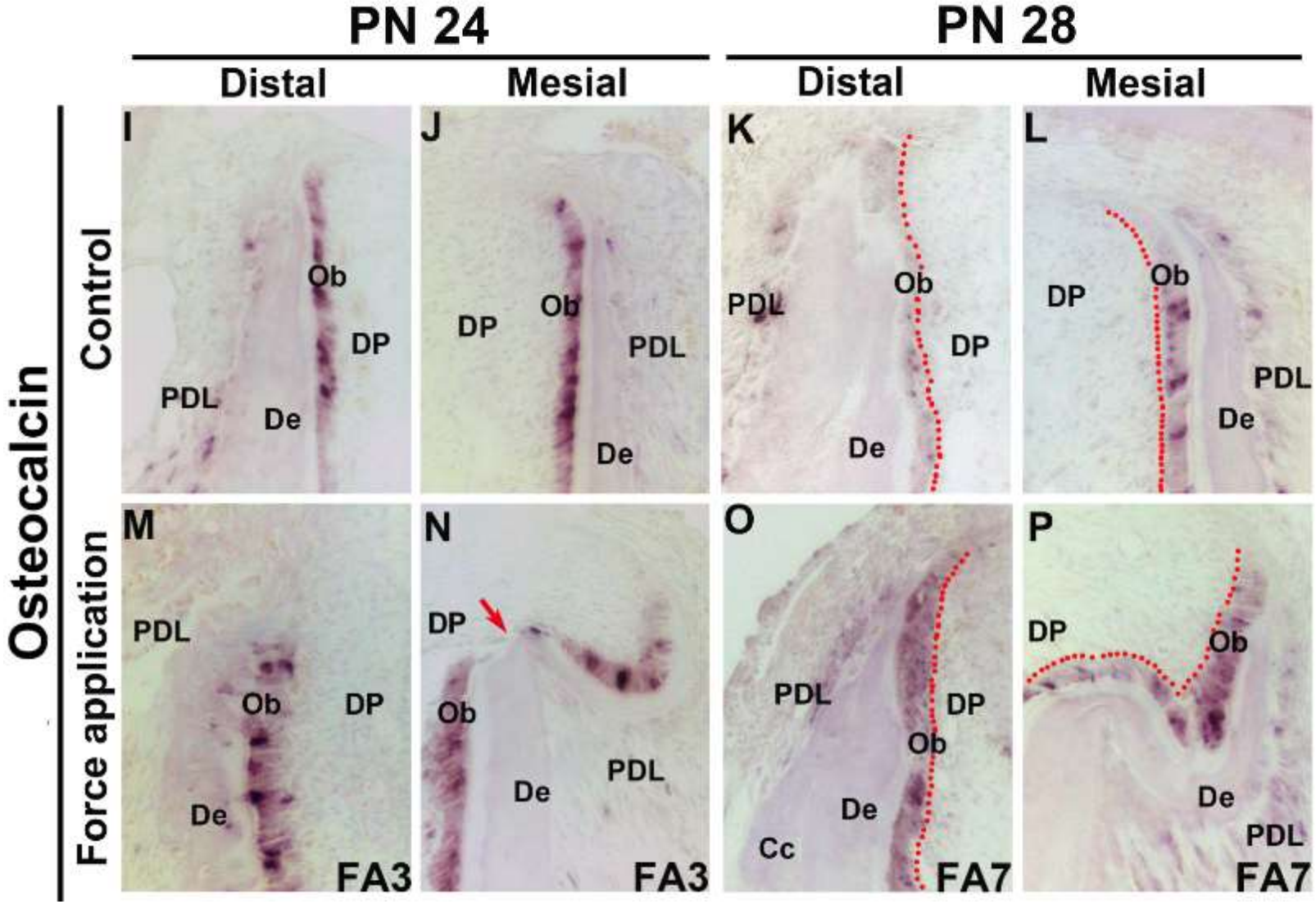
(Colognato, et al. 2000; Waddington, et al. 2001 Huang X, et al. 2009)

Results

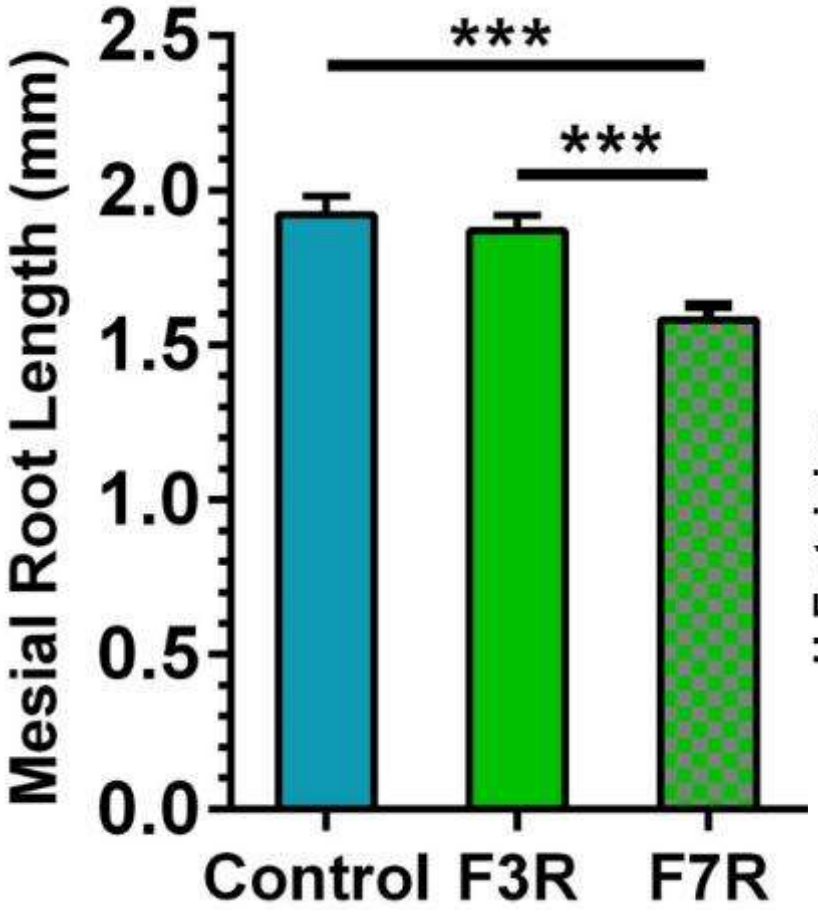


(n=8-10 teeth/group; ***: P<0.00025; NS: not significant)

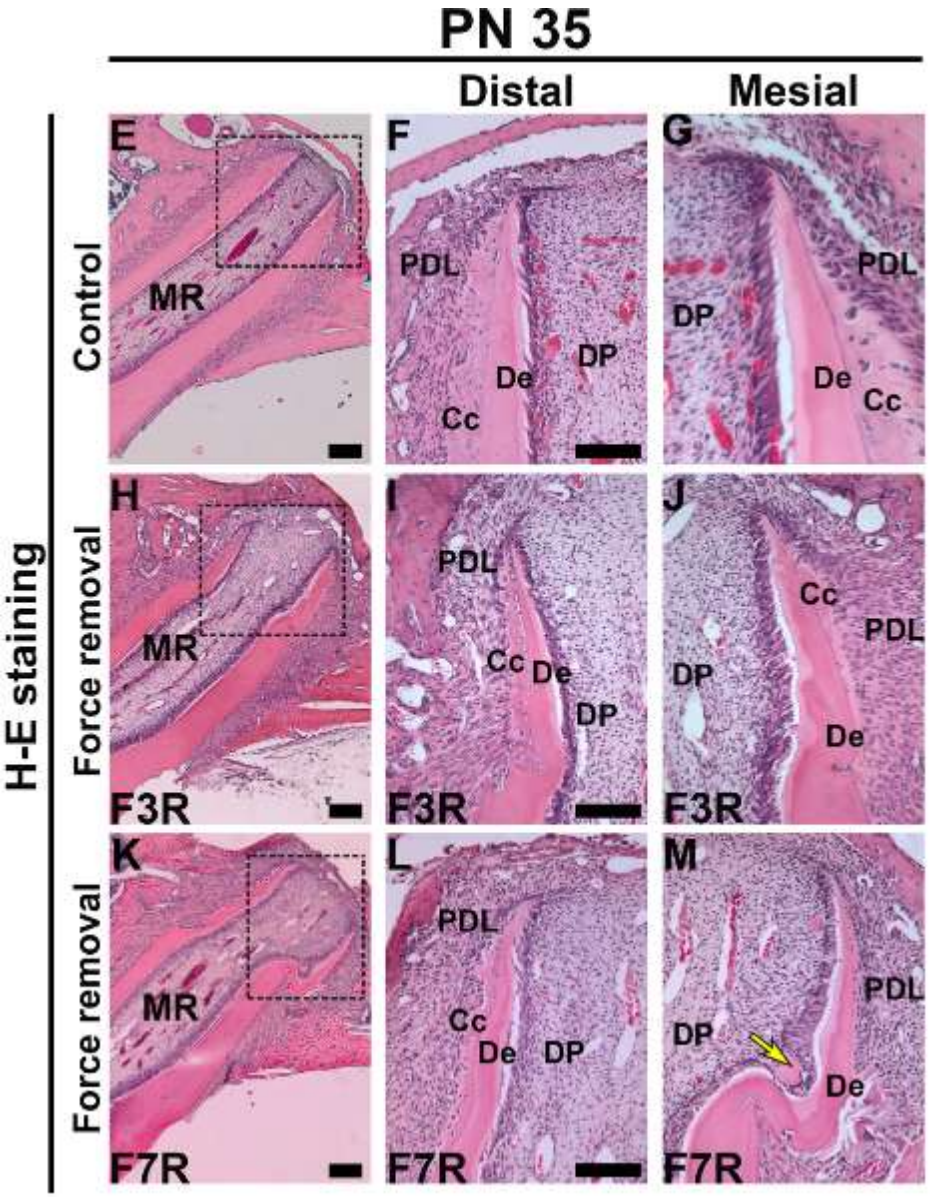
Apical gene expression



Continuous root apical development after mechanical force removal

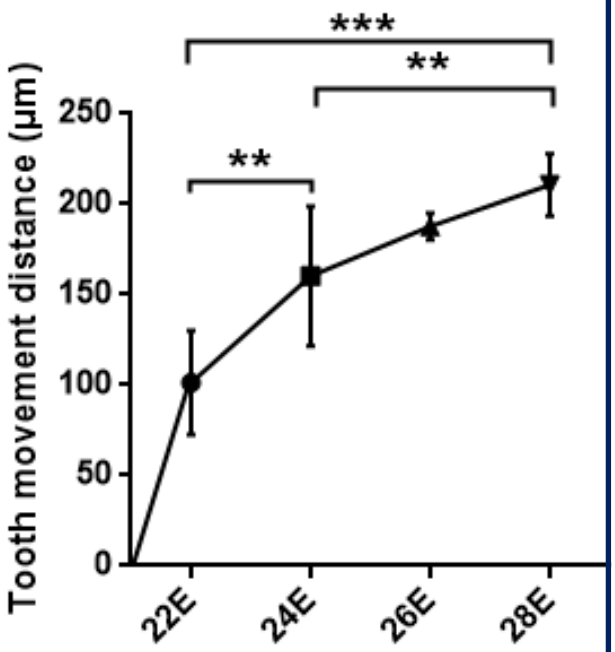


(n=8 teeth/group; ***: P<0.001)



Discussion

HERS morphological alternation



Periodontal ligament remodeling

Collagen fibres

Compression side: Maintain their overall orientation without extension initially.

Tension side: Un-calcified root apex was easily drived by tensed collagen fibres initially.

Fibroblasts: Increasing expression of laminin at initial force-applied period of 3 days.

a. Mediate attachment of the PDL cells to the root surface.
b. The increased expression of laminin might be explained by the strong visco-elastic modification of PDL in initial period of tooth movement.

(Colognato H, et al. 2000; Waddington RJ, et al. 2001; Ohshima M, et al. 2006; Naveh GR, et al. 2015.)

Conclusions

Relatively short-term force application had no obvious adverse effects on the developing root apex. However, relatively long-term force application altered root apex by affecting Hertwig's epithelial root sheath morphology and apical cellular behavior.