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Biomechanical Evaluation of Optimal Orthodontic Forces on Human Maxillary Teeth

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Abstract: As one of the key topics in orthodontics, optimal orthodontic forces have been intensively studied through human or animal experiments *in-vivo*. However, biomechanics of orthodontics involving different tissues and anatomy is rather complicated. The mechanism of orthodontics-induced mechanotransduction and levels of ideal forces for different tooth movement types have not been systematically explored. Experimental approaches are limited to providing some significant details in understanding associated biomechanics [1]. This paper aims to develop a computational modeling approach by developing anatomically accurate CT image-based 3D human maxilla models for specific patients. To investigate the ranges of optimal orthodontic forces, we apply bucally-directed tipping and bodily forces of 10g, 25g, 50g, 100g, 150g and 200g onto human maxillary canine. Following the hypothesis of the critical roles played by periodontal ligament (PDL) in orthodontic tooth movement (OTM) [2], the hydrostatic stress is quantified from nonlinear finite element analysis. The simulation is correlated to the specific clinical follow-ups *in vivo*. The results indicate that light force may not be adequate to trigger orthodontic tooth movement in an effective way, whereas heavy force may reduce OTM rate and lead to such complication as orthodontic root resorption (ORR), thereby compromising orthodontic treatment outcome. The FEA results provide new insights into relevant biomechanics in orthodontics and help establish an optimal orthodontic force level for specific patient *in silico*.

References

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