UNIVERSITI TEKNOLOGI MARA

MEASUREMENT OF SENESCENCE IN FIBROBLAST SUBJECTED TO PREDETERMINED COMPRESSIVE FORCES AND DURATION USING IN VITRO MODEL: AN ORTHODONTIC PERSPECTIVE

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Dissertation submitted in patrial fulfilment
of the requirements for the degree of
Dr In Orthodontics

Faculty of Dentistry

July 2025

ACKNOWLEDGEMENT

I am profoundly grateful to God for granting me the chance to undertake my doctoral studies and for helping me complete this challenging yet rewarding journey.

I would like to express my heartfelt appreciation to my supervisors Dr Nik Mukhriz bin Nik Mustapha, Associate Professor Dr Luay Thanoon Younis, Professor Dr Aida Nur Ashikin binti Abd Rahman, Dr Syatirah Najmi binti Abdullah and my co-researchers Puan Fara Fariza Zahar, Dr Rohanah Hussain and Ir. Jamaluddin Yusuff for their invaluable guidance, insightful feedback, and unwavering support throughout the entire research process. Their expertise and encouragement were instrumental in shaping the direction of this research and helped me overcome numerous obstacles.

I would also like to extend my sincere gratitude to the dedicated staff En Muhaimin and Puan Norita Salwa at IMMB, UiTM for their technical assistance. I am also grateful to the laboratory support staffs (Hasnida, Faizul and Suhaida) and clinical staffs of Tourmaline Postgraduate clinic of Faculty of Dentistry, UiTM (Hamimah, Azura, Fatin, Hazirah, Haslinda and Haniff) for providing the necessary support and infrastructure to conduct this research. Furthermore, I am indebted to Dr Farha Ariffin, Dr Syed Bazli Alwi Syed Bakhtiar, Dr Zatilfarihiah Rasdi and all orthodontics lecturers, whose understanding and constant encouragement provided me with the strength and motivation to persevere through the demanding phases of this study.

I am especially grateful to Mr. Ang and Mr. Choo from BioDiagnostics Sdn. Bhd. for their generous technical assistance provided at no cost to me.

I am deeply indebted to my parents and husband for their unconditional love, encouragement, and unwavering belief in my abilities. Their support provided me with the strength and motivation to persevere through difficult times and to stay focused on my goals. I am also thankful to my relatives who have been a constant source of inspiration and support throughout my academic journey.

Finally, I would like to acknowledge my friends and colleagues for their camaraderie, intellectual stimulation, and emotional support throughout this doctoral journey. A special shout out to my dearest Orthobots (Nisreen, Nadira and Suhaila), Syarifah Fariza, Suzanne Husun, Siti Raihanah, Fathy, Nabilla, Shameera, Atiqah, Sarah, Kamil, Luna, Safiza, Ainaa, Hazirah, Sabrina and Noraina Hafizan and my high school girlfriends.

Without the support of others, completing a dissertation would not be possible.

Last but not least, I would like to thank my own-self, for never stopping to believe in the impossible. From the depth of darkness into light (2:257).

ABSTRACT

Orthodontic treatment aims to align teeth by remodelling the periodontium, induced by orthodontic force. To ensure effective and safe treatment, understanding the underlying biomechanical and biological causes of tooth movement is crucial. The compression-tension theory, which proposes that chemical messengers regulate cellular responses to mechanical stress on the periodontal ligament and alveolar bone, has been widely accepted (Meikle, 2005). However, the optimal forces on fibroblasts remain unknown. In recent years, new findings about cellular senescence and biological changes to the periodontium have been published (Mohanakumar et al., 2021). High compressive forces may lead to hypoxia, causing irreversible cell cycle arrest, apoptosis, and loss of surrounding tissue cells, particularly in the compression zone. Excessive hypoxia may cause significant and detrimental destruction of tooth-supporting tissues (Younis et al., 2019). To minimize the detrimental effects of these forces, assessing senescence levels in response to different compressive forces may help control orthodontic forces and preserve the periodontal structure and root surface. This study examined the cellular senescence activity in human periodontal ligament fibroblasts using an in vitro compressive model. The cells were exposed to different force magnitudes and observed over time to assess their senescence. However, the research is limited as it only used a two-dimensional model, which may not fully capture the cellular response seen in the mouth. This is a fundamental investigation intended to inspire further research on the mechanisms of cellular senescence and its relevance for orthodontic treatment. Future studies could explore cellular senescence ex vivo and develop or use targeted senolytics to enhance orthodontic outcomes

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CHAPTER 1
INTRODUCTION

1.1 Research Background

Orthodontic treatments are a common and essential aspect of dental care, often involving the application of mechanical forces to facilitate the movement and alignment of teeth. These mechanical forces exerted on the alveolar bone and periodontal ligament can induce a cascade of biological responses, including bone remodelling and resorption (Li et al., 2019; Masella & Meister, 2006) Interestingly, the compressive force experienced by the periodontal ligament during orthodontic treatment has been shown to influence various cellular processes (Li et al., 2019).

Cellular senescence is a state of permanent cell cycle arrest, which can be triggered by various cellular stressors, including mechanical stress (Li et al., 2019). Understanding the impact of compressive forces on cellular senescence in the periodontal ligament is crucial, as it may shed light on the underlying mechanisms of orthodontic tooth movement and the potential long-term consequences of such treatment.

To study the effects of compressive forces on cellular senescence, an in vitro compression model can be a valuable tool. This model allows for the controlled application of compressive forces on periodontal ligament cells, enabling researchers to observe and analyse the resulting cellular responses, including the induction of senescence.

From an orthodontist's perspective, the insights gained from such an in vitro compression model can contribute to a deeper understanding of the biological processes involved in orthodontic tooth movement. By elucidating the fundamental relationship between mechanical stress and cellular senescence, orthodontists can potentially optimize treatment protocols, mitigate adverse effects, and improve the overall outcomes of orthodontic interventions.

In response to compressive forces, the periodontal ligament has been shown to exhibit various biological responses, including the production of vascular endothelial growth factor (Miyagawa et al., 2009). This growth factor plays a crucial role in regulating angiogenesis and tissue perfusion, which can be essential for the maintenance