

# CORTICOTOMY ENHANCED ORTHODONTICS

A thesis submitted in partial fulfilment of the requirements for the degree of  
Doctor of Clinical Dentistry (Orthodontics)

by

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**Please note:  
There is no Appendix 6  
included in the digital  
or print copies**

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# 3. SIGNED STATEMENT

This report contains no new material that has been accepted for the award of any other degree or diploma in any other university. To the best of my belief, it contains no material previously published except where due reference is made in the text. I give consent for this copy of my thesis, when deposited in the University library, to be made available for loan and photocopying.

Mun Jing JONG

# 4. SUMMARY

The main aims of this study were to evaluate the effect of both a flap and corticotomy procedure on orthodontic tooth movement in rats and to compare the bone changes against a control group. Furthermore, the study aimed to introduce a new design for an appliance, which would allow buccal tooth movement in a rat model.

Male Sprague-Dawley rats (n=36) aged 6-8 weeks were obtained from Laboratory Animal Services (Adelaide University) with ethics approval from The University of Adelaide Animal Ethics Committee (Project number: M-2009-172). There were 3 control groups, each with 6 rats: nil intervention; flap surgery; corticotomy procedure. These formed the baseline comparison to the experimental groups: tooth movement only; flap surgery and tooth movement; and corticotomy with tooth movement; 4 rats were excluded due to anaesthetic death or appliance failure but were replaced with ethics approval from The University of Adelaide Animal Ethics Committee (Project number: M-2009-172B) such that 6 rats remained in each group.

	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>	<b>Group 5</b>	<b>Group 6</b>
<b>Appliance</b>	No	No	No	Yes	Yes	Yes
<b>Surgery</b>	No	Flap	Corticotomy	No	Flap	Corticotomy

The timeline for the experiment was 7 days with a Calcein bone label injection at 3 days prior to appliance insertion, an Alizarin Red bone label injection at 5 days after appliance insertion, and sacrifice at 7 days after appliance insertion. Throughout the experimental period, Buprenorphine (0.05mg/kg. Tradename: Temgesic and comes as 324µg Buprenorphine Hydrochloride which was then diluted) I.P. was given twice daily for pain relief, in all tooth movement groups. Sacrifice was with Lethobarb Euthanasia Injection (60mg/mL with 1mL/Kg of a barbiturate derivative made by Virbac (Australia)). Following this period, the rat maxillae was dissected out and prepared for resin embedding and micro-CT scanning. Micro-CT scanning was performed in a Skyscan 1174 at the Institute of Medical and Veterinary Science (IMVS) with hydroxyapatite standards (250 mg HA/cm<sup>3</sup> and 750 mg HA/cm<sup>3</sup>) to allow for quantitative analysis and comparison between the samples produced. Software for reconstruction was NRecon (v1.4.4, Skyscan, Kontich, Belgium) and for measuring gray levels was CT Analyser (v1.8.05, Skyscan, Kontich, Belgium).

Resin embedding (**Appendix 1**) allows for histological analysis and observation of the bone labels and calculation of the bone mineralisation rates.

Impressions using Honigum heavy body (DMG-dental, Gunz Dental, Australia) were taken at appliance insert and again at sacrifice. Honigum is an A-silicone and was used in the automix-cartridge form. These impressions and the dissected rat maxillae were photographed using an Olympus stereomicroscope (SZX2-ILLT, Tokyo, Japan) and captured with Analysis Software (v 5.1 (Build 1276), Olympus Soft Imaging Solutions, GMBH) and measurements from the resultant pictures were performed, using image J (1.43u, National Institute of Health, USA).

For those rats which required insertion of an appliance, an additional impression was taken at the time of calcein bone label injection so that an individual appliance could be fabricated for each rat. This appliance was inserted 3 days later under deep anaesthesia using Hypnorm/Hypnovel/Water in a 1:1:2 mix. Hypnorm (0.315mg/mL Fentanyl with 10mg/mL Fluanisone) and Hypnovel (5mg/mL Midazolam) are mixed separately with sterile water in a 1:1 ratio. Once mixed, the resulting solutions are mixed together, on a 1:1 basis. All rats were monitored closely until recovery.

Following the 7 day experiment and matching each experimental group with its correlated control group; Group 4 (appliance, nil surgery) rats displayed 0.08mm greater movement than Group 1 rats, Group 5 (appliance, flap surgery) rats 0.29mm greater movement than Group 2 rats, Group 6 (appliance, corticotomy) rats 0.38mm greater movement than Group 3. Overall, Group 6 was statistically significant compared to all control rat groups (1, 2 and 3), whilst Group 5 was statistically significant only to Group 2 rats and Group 4 rats were not statistically significant to any other group. However, Group 6 tooth movement was not statistically different to Groups 4 and 5.

With regards to bone changes there was no statistically significant difference between the groups and as such, we could not show that a surgical intervention (either flap or corticotomy) could produce significant osteopenia when combined with orthodontic tooth movement over 7 days. There was increased osteopenia when comparing either surgical intervention with nil surgery, but this did not reach statistical significance. This was measured using micro-CT scans with hydroxyapatite standards.

As with all experiments, especially those involving biological research, many factors could have affected the outcome. Casual observation of the micro-CT scans would indicate noticeable changes between groups in the osteopenic response by the bone. This would agree with other reports in the literature but our results were not statistically significant. Post-experimental analysis revealed that approximately 66 rats may have given a significant

interaction but, in addition, there were issues with appliance failures, lack of pre-treatment micro-CT and other methodological considerations.

In conclusion, although greater than average distance changes and demineralisation changes were seen in the corticotomy and flap groups, these did not reach statistical significance. Although we could not prove this definitively, it is likely that this induced osteopenia is the reason for the increase in tooth movement. Further research is required, to provide longer observation periods and to elucidate if the other benefits of a corticotomy procedure, for example, decreased root resorption, are supported with evidence.